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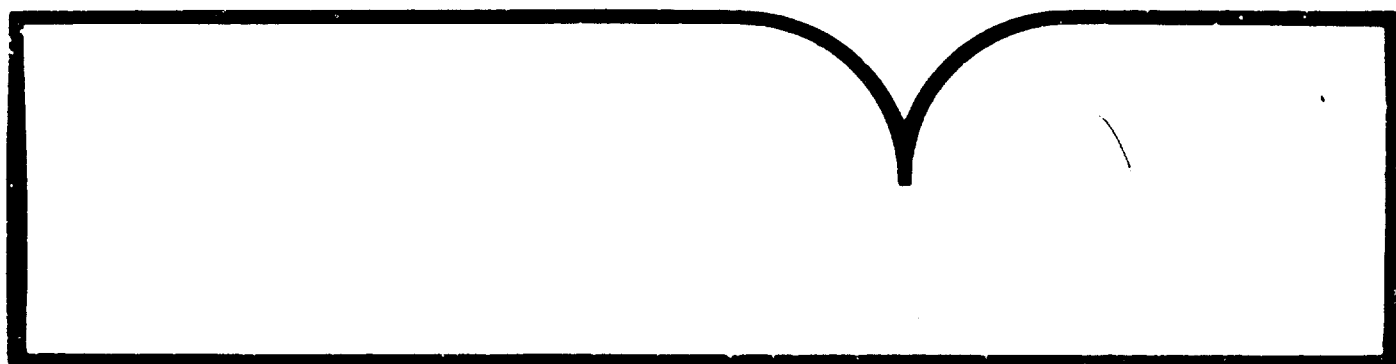
**Development of Draft Construction Safety  
Standards for Excavations. Volume 2**

**(U.S.) National Bureau of Standards  
Washington, DC**

**Prepared for**


**National Inst. for Occupational Safety and  
Health, Morgantown, WV. Div. of Safety Research**

**Apr 83**



**U.S. Department of Commerce  
National Technical Information Service**

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10. SUPPLEMENTARY NOTES   <div style="text-align: right;">  </div> <div> <input type="checkbox"/> Document describes a computer program; SF-185, FIPS Software Summary, is attached.       </div>			
11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)  <p>A record of an interim stage in the development of revisions to existing Occupational Safety and Health Administration (OSHA) regulations governing excavations, trenching and shoring practices in the construction industry, Subpart P 29 CFR 1926, is presented. The National Bureau of Standards (NBS) prepared a working draft of recommended changes to the regulations based on previous NBS technical studies.<sup>1/</sup> Five regional industry workshops were held to discuss the proposed revisions. Included in the report is a copy of the recommended revisions, which were submitted to the workshops, and a record of industry's response in the form of suggestions, commentary and summaries of workshop activities. The key section of the report presents an analysis of industry response and resulting recommendations. The document is a record intended to aid OSHA during subsequent stages of the rule-making process.</p> <p><sup>1/</sup> Yokel, F. Y., "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavation," NBS Building Science Series 127, June 1980.</p>			
12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons) <b>braced excavations; construction; Federal regulations; retaining structures; safety; shoring; slope stability; soil classification; soil pressures; standards; trenching</b>			
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# **Development of Draft Construction Safety Standards for Excavations**

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## **An NBS/NIOSH Publication Volume II**

U.S. DEPARTMENT OF COMMERCE  
National Bureau of Standards  
National Engineering Laboratory  
Center for Building Technology  
Geotechnical Engineering Group  
Structures Division  
Washington, DC 20234

April 1983

Prepared under Interagency Agreement No. 82-06-M for:  
**Department of Health and Human Services**  
**Public Health Service**  
**Centers for Disease Control**  
**National Institute for Occupational Safety and Health**  
**Division of Safety Research, Morgantown, WV 26505**  
**Ronald L. Stanevich, Project Officer**

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DHHS (NIOSH) PUBLICATION NO. 83-103

## **DEVELOPMENT OF DRAFT CONSTRUCTION SAFETY STANDARDS FOR EXCAVATIONS**

An NBS/NIOSH Publication

Volume II

Felix Y. Yokel

U.S. DEPARTMENT OF COMMERCE  
National Bureau of Standards  
National Engineering Laboratory  
Center for Building Technology  
Geotechnical Engineering Group  
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and

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U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*  
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*



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## 1. INTRODUCTION

This volume contains background information and supplements Volume I of the report. Section 2 contains workshop summaries prepared by the NBS author and by workshop organizers; Section 3 contains responses by the NBS author to correspondence associated with the industry workshops; Sections 4 through 8 contain depositions made in the five workshops; Section 9 contains source documents for the present version of Subpart P; and Section 10 contains miscellaneous input and information contributed by workshop participants and others.

## 2. WORKSHOP SUMMARIES AND PROCEEDINGS

The following workshops were held:

Milwaukee, WI	June 9, 1981
Atlanta, GA	June 16, 1981
Dallas, TX	June 30, 1981
San Francisco, CA	July 9, 1981
Boston, MA	July 14, 1981

This section contains a memorandum by the NBS author on each of the workshops which summarizes the comments. Depositions made in the workshops are attached to these memoranda. Additionally, there are reports by the local sponsors on the Milwaukee, WI, and Dallas, TX, workshops.

The workshop reports contain information on the workshops as well as analyses of some of the comments and depositions.



UNITED STATES DEPARTMENT OF COMMERCE  
National Bureau of Standards  
Washington, D.C. 20234

Bldg. 226, Room B162  
(301) 921-2648

June 23, 1981

Mr. Edward Hayden  
Mr. Arthur Schmuhl  
Mr. James Lapping  
Mr. John Ramage  
Mr. Paul Bouley  
Mr. Ronald Stanevich  
Prof. Jack Mickle  
Mr. John Pannullo

Gentlemen:

Attached is a copy of my draft memorandum on the Milwaukee Workshop. Please send me your comments before July 3. I shall revise the memo after I receive your comments. In particular, I want to make sure that I have no inaccuracies and that I didn't fail to address important issues which were raised.

Sincerely,

A handwritten signature, likely of Felix Y. Yokel, is written in cursive script below the word "Sincerely,".

Felix Y. Yokel, Leader  
Geotechnical Engineering Group  
Structures and Materials Division  
Center for Building Technology, NEL

Attachment

cc: Mr. John Chambliss  
Mr. William Driskill  
Mr. Paul Henson  
Mr. Clifford Simmons  
Mr. Bill Zoino



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D R A F T

June 23, 1981

MEMORANDUM FOR Records of the NIOSH Excavation Project

From: Felix Y. Yokel

Subject: Workshop in Milwaukee, Wisconsin, June 9, 1981

This memorandum is to record my overall impression and my reaction to important questions that were raised in the Workshop. A Workshop Report, containing recommendations is being prepared by the Organizing Committee, using taped records and written depositions.

(1) General: There were both negative and positive comments. However, it is in the nature of this type of a Workshop that individuals who have negative comments and recommendations for change will go on record, while those who generally agree with the recommendations will see no need to make a statement. There were some statements particularly from contractors from Illinois, that a change in the present standard is not desirable. To the extent that these statements are not accompanied by specifics it is difficult to determine whether the status quo is considered desirable because Subpart P as written is satisfactory or because of the fact that the present version of Subpart P is unenforceable.

(2) Soil Classification: There were substantial comments to the effect that a 1/2 to 1 slope should be permitted in Type A soil. In a technical sense I see no problem in changing the allowable slopes for Type A soils to 1/2 to 1 for 12 ft. or less and 3/4 to 1 for 12 to 20 ft. We originally did not recommend 1/2 to 1 slope because there was no substantial evidence that it is being used and there was some concern that it could become a vertical slope when the work is sloppy.

(3) Local Provisions Which Have a Proven Performance Record: In our summary recommendation (BSS 127) the following statements were made in Appendix A: page 59, A.3, 1st paragraph:

"Traditional timber shoring practice varies widely from location to location and frequently depends on such variables as sizes and characteristics of available timber, soil conditions, and local work practices. In some locations these practices have been used for many years and appear to be satisfactory to all the parties concerned. Three such locations are the State of Wisconsin, New York City, and the State of California (where mainly softwood is used)."

Page 65, 2nd paragraph:

"Since, in spite of the results of this analysis, NBS could find no evidence that traditional timber practice, if properly executed, is unsafe, consideration could perhaps be given to temporarily exempting conventional timber shoring from the lateral load requirements until lateral load effects can be further studied by actual measurements in the field. If such an approach is adopted, it may be more reasonable to endorse proven local shoring practices on a regional basis, only where such shoring is widely used. It is not recommended to use a single scheme such as Tables A.2, and A.3 nationwide, since local practice evolved on the basis of local workmanship, material supplies and soil conditions."

It can be seen from our summary report that the question which arose in the Milwaukee Workshop was anticipated. It may arise again in the San Francisco and the Boston Workshops. The question is this:

If we have a local shoring practice which is satisfactory to all the parties concerned, should it be changed to comply with the new provisions?

If it is not changed, by which mechanism can it be approved without jeopardizing the consistency of the new provisions?

This is a question which must be taken up by the Advisory Committee in order to come up with a definite recommendation to OSHA. I would like to state some of my preliminary thoughts:

- (a) If we have a traditional practice which has a good track record and we force contractors to change it, we may well cause an increase in the accident risk and thus defeat our overall purpose. On the other hand, one of our goals was to get away from prescriptive provisions and provide more options. Thus it would also be wrong to enforce this traditional approach to the exclusion of other approaches.
- (b) The evidence on which we can base the permission to use a traditional practice which does not comply with our recommended provisions is its track record, rather than compliance with engineering principles. Thus, if it is allowed, no changes in it should be permitted. Such changes would include substitution of any of its members by other members of "equivalent" strength.

Thus I think that one way to deal with this problem could be some kind of "grandfather clause," by which widely used traditional practices could be allowed on a regional basis. However, care should be exercised to permit only those parts of these practices which are actually widely used, and discard other parts which do not have a proven track record.

Since we are dealing with a specific case of the Wisconsin Administrative Code, I analyzed their timber tables (see Appendix). My compliance measure is the "Safety Index"  $S/S_a$ , where  $S$  = calculated stress and  $S_a$  = allowable stress. My "Allowable Stress" is the stress for "Mixed Hardwood I", Table 5, page 29, multiplied by 1.33 for short term:  $f_b = 964$  psi,  $f_c = 499$  psi.

The safety index for struts was calculated for 2 situations: with the 240 lb. gravity load at the center of the strut as required, and without the gravity load to assess general adequacy in resisting lateral loads.

Hereafter is a summary of the assessment:

- Table 1: Struts in rows 1-5 are generally adequate to resist the lateral loads, but are overstressed when the 240 lb. gravity load is applied. In row 6 the situation is similar for Type B soil (no water) but very marginal for Type C soil. The wales in row 6 are heavily overstressed.
- Table 2: Situation is similar to Table 1 including that in row 5, which corresponds to row 6 in Table 1.
- Table 3: The table is more stringent than the proposed spacing provisions.
- Table 4: This table is for Type B soils. Struts tend to be overstressed and wales severely overstressed.
- Table 5: This table is for wide trenches in Type A soils. It was analyzed for 6 ft. widths and 12 ft. widths. It can be seen that, with the 240 lb. load the struts are adequate to 6 ft. width, but overstressed for the 12 ft. width.

There was some evidence from the answers to my questions in the Workshop that only Table 1, rows 1-5 and Table 3 are widely used. If this is the case, some of the more marginal cases should probably be eliminated, while the rest of the practice could be endorsed on the basis that it is successfully used. It should be noted that the greatest deficiency occurs in wales where the spacing is 11-1/2 ft.

(4) Exposure: Section 1926.650 (a), which was formulated in the Washington AGC Workshop, sets a scope for the provisions. After the Wisconsin Workshop it appears that this section needs to be made more explicit to state that the provisions don't apply where workers are not exposed to the effects of mass movement of soil or rock. This may have to be further amplified to state how far away from an unshored or inadequately shored face workers would have to be when they are not exposed. ✓

Resolution of this question would solve two problems:

- (a) In wide excavations the provisions would not necessarily apply. Thus the demand to distinguish between trenches and excavation would be satisfied in this way.
- (b) When long pipe sections are laid, cross braces interfere even when they are widely spaced. Thus it is sometimes

(5) Scope of Standard Practice: In the Workshop document it was originally proposed to limit the standard practice to a 20 ft. depth. The AGC Washington Workshop recommends 24 ft., and this seems to be supported by most contractors. AFL-CIO proposed 15 ft. ASFE originally proposed 20 ft. This issue should receive serious discussions in the other Workshops and the parties should attempt to reach a resolution.

(6) Engineer, Qualified Person, Competent Person: Almost all the parties seemed to agree that there must be a competent person on the job site.

There is disagreement whether a "qualified person" must be a licensed engineer. AFL-CIO maintains that this is necessary, while many contractors want a broader definition. There is agreement that the "registered architect" should be dropped from the definition of "Accepted Engineering Requirements."

There was considerable confusion between the terms "competent person" and "qualified person," however, it was probably caused by inadequate study of the Workshop document.

(7) Dust Control: It was noted that Section 1926.651 (i) conflicts with present EPA requirements. The section is also advisory rather than mandatory and may not belong in the regulation (it could be in the guidelines).

(8) Stoplogs: It was noted that the provisions of Section 1926.651 (g) are not practical for excavation work.

(9) General Recommendations: One of the speakers noted that the environment changed, and the contractor is now in a position of responsibility rather than in an adversary position when it comes to work safety. This Workshop convinced me that, while we have a good basic approach, we will need to resolve many issues, some of which result from regional differences. The Workshops will bring these issues to the surface, but there will not be enough time to resolve any of these issues. This will have to be accomplished after the Workshops.

I therefore strongly recommend that the parties participating in the Workshop form a committee which can work with NIOSH-OSHA-NBS when the recommendations are formulated. I also strongly urge OSHA-NIOSH to fund an additional effort in this area, so that a strong justification (technical, statistical and other) can be developed for all the final recommendations.



NOTES ON ANALYSIS OF TABLES

H = depth of excavation  
h = horizontal center to center spacing of struts  
v = vertical center to center spacing of struts  
B = width of trench

Table 1: Row 2 could be A or B soils  
Row 6 could be B or C soils

Table 2: Row 2 could be A or B soils  
Row 5 could be B or C soils

Table 4: Analysis was carried to 24 ft. depth, for greater depths  
safety index will decrease.

Table 5: Analysis was made for 6 and 12 ft. widths.

**TABLE 1—TRENCH TIMBERING REQUIREMENTS**  
For trenches not exceeding 10 feet in depth and width not exceeding 42 inches

	Kind of Soil	Uprights	Cross Braces	Stringers**	H	h	v	B	Soil	SAFETY INDEX		
										Struts with 240-lb. load	Struts without 240-lb. load	Wale
Where no parallel excavations exist or have existed within 10 ft.	Hard, solid soil	2x6 inch planks spaced 6 ft. o—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	None	10'	6'	3.3'	3.5'	A	0.76	1.31	
Previous excavations 6-10 ft. from trench	Hard, solid soil	2x6 inch planks spaced 4 ft. o—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	None	10'	4'	3.3'	3.5'	A	0.91	2.27	
									B	0.65	1.13	
Previous excavations less than 6 ft. from trench	Hard, solid soil	2x6 inch planks spaced 3 ft. o—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	None	10'	3'	3.3'	3.5'	B	0.76	1.31	
Irrespective of any previous excavation	Soil that splits easily	2x6 inch planks spaced 3 ft. o—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	1x6 inch boards placed back of uprights near top of trench	10'	3'	3.3'	3.5'	B	0.91	2.27	
Irrespective of any previous excavation	Gravelly or filled in ground	2x6 inch planks spaced 2 ft. o—c	*2—2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft.	1x6 inch boards placed back of uprights near top of trench	10'	2'	3.3'	3.5'	B	0.91	2.27	
Irrespective of any previous excavation	Sand or very wet soil	2 inch tight sheathing	3x6 inch timbers or equivalent horizontally spaced not exceeding 6 feet	3x6 inch timbers or equivalent—2 for depths 7 ft.; 3 for depths 7 ft. to 10 ft.	10'	6'	3.3'	3.5'	B	0.85	1.13	0.3
									C	0.45	0.57	0.15

Notes: o—c means center to center.

\* In line of three cross braces for each upright, but each stringer may be used with substantial cross beams spaced horizontally sufficient to give equivalent protection, but in no case exceeding 6 feet.

\*\*Stringers shall be properly supported by posts or chocks.

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**TABLE 2—TRENCH TIMBERING REQUIREMENTS**

For trenches over 10 feet and not exceeding 15 feet in depth and width not exceeding 42 inches

										SAFETY INDEX		
	Kind of Soil	Uprights	Cross Braces	Stringers**	H	h	v	B	Soil	Strut with 240-lb. load	Strut Without 240-lb. load	Wale
Where no parallel excavations exist or have existed within 15 ft.	Hard, solid soil	2x6 inch planks spaced 4 ft. c-c	*3—2x6 inch planks or equivalent for depth under 13 ft.; 4 for depths 13 ft. to 15 ft.	None	15'	4'	3.75'	3.5'	A	0.71	1.33	
Previous excavations 10 to 15 ft. from trench	Hard, solid soil	2x6 inch planks spaced 3 ft. c-c	*3—2x6 inch planks or equivalent for depths under 13 feet; 4 for depths 13 ft. to 15 ft.	None	15'	3'	4'	4'	A	0.82	1.77	
									B	0.56	0.89	
Previous excavations less than 10 ft. from trench	Hard, solid soil	2x6 inch planks spaced 2 ft. c-c	*3—2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.	None	15'	2'	4'	4'	B	0.71	1.33	
Irrespective of any previous excavations	Soil that splits easily	2x6 inch planks spaced 2 ft. c-c	*3—2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.	1x6 inch boards placed back of uprights near top of trench	15'	2'	4'	4'	B	0.71	1.33	
Irrespective of any previous excavations	Sand, gravel filled in ground or very wet soil	2 inch tight sheathing	3x6 inch timbers or equivalent, spaced 6 ft. c-c	6x6 inch timbers or equivalent—3 for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.	15'	6'	3.75'	3.5'	B	0.56	0.66	0.36
									C	0.30	0.33	0.18

\*Notes—\* means center to center

\*\*In line of trench extra bracing for each upright, but such stringers may be used with substantial cross braces spaced horizontally sufficient to give equivalent protection, but in no case exceeding 6 feet.

\*\*\*Stringers shall be properly supported by posts or chocks.

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**TABLE 3—TRENCH TIMBERING REQUIREMENTS**  
For trenches over 16 feet in depth and width not exceeding 42 inches

	Kind of Soil	Uprights	Cross Braces	Stringers**	Depth	Wisconsin		Table 4 (a)	
						C-C	CLR	C-C	CLR
Irrespective of any previous excavations	Hard, solid soil	2"x8" 2' o-c 15'-17'	Use Table No. 4	Use Table No. 4	15'-17'	2'	1.5'	4'	2'
		2"x8" 1' o-c 17'-20'			17'-20'	1'	0.5'	4'	2'
	Soil that splits easily, sand, gravel, filled in ground, or very wet soil	2"x8" tight over 20'							
		2" tight sheathing							

Notes: a—4 braces needed in each

\*\*Stringers shall be properly supported by posts or chocks.

Revised September 1978, No. 17  
Trenching and Shoring Code

**TABLE 4—TRENCH TIMBERING REQUIREMENTS**

For trenches over 42 inches in width up to and including 12 feet in width

Depth of Trench	Uprights	Cross Braces	Strengthening	H	h	v	B	Soil	SAFETY INDEX		
									Strut With 240-lb. load	Strut Without 240-lb. load	Wale
Over 42 in. to 10 ft. incl.	(*)	6x6 inch timbers spaced horizontally 7 ft. face to face	6x6 inch timbers spaced 4 ft. c-c	10	7.5	4	12	B	0.64	1.00	0.21
		6x6 inch timbers spaced horizontally 11 ft. face to face	6x6 inch timbers spaced 4 ft. c-c	10	11.5	4	12	B	0.52	0.65	0.09
Over 10 ft. to 20 ft. incl.	(*)	6x6 inch timbers spaced horizontally 7 ft. face to face	6x6 inch timbers spaced 4 ft. c-c	20	7.5	4	12	B	0.63	0.75	0.16
		6x6 inch timbers spaced horizontally 11 ft. face to face	6x6 inch timbers spaced 4 ft. c-c	20	11.5	4	12	B	0.79	0.87	0.16
Over 20 ft. to 30 ft. incl.	(*)	6x6 inch timbers spaced horizontally 7 ft. face to face	6x6 inch timbers spaced 3 ft. c-c	24	7.5	3	12	B	0.9	1.08	0.30
		6x6 inch timbers spaced horizontally 11 ft. face to face	6x6 inch timbers spaced 3 ft. c-c	24	11.5	3	12	B			
Over 30 ft. to 40 ft. incl.	(*)	6x6 inch timbers spaced horizontally 7 ft. face to face	6x6 inch timbers spaced 3 ft. c-c								
		10x10 inch timbers spaced horizontally 11 ft. face to face	10x10 inch timbers spaced 3 ft. c-c								

(\*) Uprights shall consist of 3 inch planks and spaced to comply with specifications for trench less than 42 inches in width.

**TABLE 5—TRENCH TIMBERING REQUIREMENTS**

For trenches 42 to 16 feet in depth, 34 to 12 feet in width, and cut in hard soil\*

Depth (ft.)	Width (ft.)	Uprights	Cross Braces	H	h	v	B	Soil	SAFETY INDEX		
									Strut With 240-lb. load	Strut Without 240-lb. load	Wale
42-8	34-10	6x6 inch planks spaced 4 ft. c-c	3-6x6 inch struts spaced 4 ft. c-c	8'	4'	4'	12'	A	0.78	1.28	3.51
8-10	10-12	6x6 inch planks spaced 4 ft. c-c	3-6x6 inch struts spaced 4 ft. c-c	12'	4'	4'	12'	A	0.70	1.08	2.34
10-10	10-10	6x6 inch planks spaced 4 ft. c-c	4-6x6 inch struts spaced 4 ft. c-c	15'	4'	4'	12'	A	0.65	1.87	
							6'		0.97		

\*In case unstable soil is encountered, boring shall immediately report back to that noted in Table 4.

Shelby Co. Register, December, 1908, No. 64, col. 1; 4th, sec. (1) (inter.), 190 and 190, Register, September, 1908, No. 579, col. 10-1-10.

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Gentlemen:

Attached is a copy of my draft memorandum on the Atlanta Workshop. Please send me your comments before July 10. I shall revise the memo after I receive your comments. In particular, I want to make sure that I have no inaccuracies and that I didn't fail to address important issues which were raised.

Sincerely,

Felix Y. Tokel, Leader  
Geotechnical Engineering Group  
Structures and Materials Division  
Center for Building Technology, NEL

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D R A F T

June 23, 1981

MEMORANDUM FOR Records of the NIOSH Excavation Project

From: Felix Y. Yokel

Subject: Workshop in Atlanta, Georgia, June 16, 1981

This memorandum is in addition to proceedings which are being prepared by the Construction Trade Department of the AFL-CIO and is intended to cover important issues raised by the Workshop as perceived by me.

(1) General: My general impression from this Workshop was that even though many important points in our input document were disputed and criticized, the document was by and large well received. We did not encounter the problem which exists in Wisconsin, where existing shoring regulations and practices, which are locally considered satisfactory do not meet all the provisions in the proposed standard. We also did not encounter comments such as those voiced by Indiana contractors who question the need for any change in the existing regulations. However, several very important issues were raised and are subsequently discussed.

(2) Soil Classification: The overall approach in Table 1 was well received, but several important issues were raised:

As in the previous Workshop, the need to permit 1/2 in 1 slope for Type A soil was perceived. Beyond that, the AGC of Kentucky proposed that a 5 ft. cut at the bottom of a 1/2 in 1 slope be permitted for Type A soil and a 3 ft. cut at the bottom of a 3/4 in 1 slope be permitted for Type B soil. The Kentucky AGC, as well as the ASFE representative also raised a question about the lack of specifics in defining "vibrations" in the footnote 1 to Table 1. In addition, it was suggested that instead of changing abruptly from one slope to another at the 12 ft. depth, the slope be gradually decreased as the depth increases from 12 to 20 ft.

I have the following comments on these suggestions:

I would go along with a 1/2 in 1 slope for Type A soil. I also do not object to a gradual transition in allowable slopes as you go from 12 ft. to 20 ft. depth, though I think it may cause enforcement problems (originally we proposed a gradual transition, but we dropped

it subsequently because we thought it may be too complicated to implement). I consider the 5 ft. cut at the bottom of a 1/2 in 1 slope for Type A soil as too risky. I think that the comment on vibrations is valid, and I think we may have to drop our reference to vibration unless we can come up with specifics (heavy traffic and pile driving within a specific distance). However, such specifics without research data may be difficult to justify.

(3) Need for Simplicity: The need for simplicity and elimination of all duplication was stressed. I believe that there is a need to take a look at the entire write-up of the revised Subpart P, to eliminate all duplication and to use simpler, more precise language wherever possible. This is endorsed by all the parties participating in the Workshop.

(4) Layered Soils: Footnote to Table 1 was strongly endorsed. This is important, since I had some second thoughts about this conservative provision.

(5) Fractured Rock: The definition of fractured rock was criticized as lacking precision, however, we were unable to provide a better definition.

(6) Definition of Short Term Excavations: Different opinions were expressed, however, there seemed to be a consensus that 7 days is too long and considerable sentiment to increase the time to more than 1 day. The ASFE representative warned against extending the time period too much.

(7) Role of Professional Engineer: The troubling observation was made that it may be often impossible to find a consulting engineer who wants to assume responsibility for the safety of trenches even if they are deeper than 20 ft. This may make the requirement for a professional engineer academic.

(8) Bank Next to Work Area: There seemed to be consensus that the bank next to the work area should be increased to 4 ft.

(9) Excavation Below Bottom of Trench: There seems to be consensus that allowable excavation below the bottom of sheeting should be increased to 3 ft.

(10) Competent Person: There seems to be consensus that a competent person should be at the job site.

(11) Section 652(b)(4)(ii): It was suggested to move this Section to the end of Section 652(b) since it does not concern field personnel.

(13) General Comment: Some general comments were made which touch on problems which transcend the scope of Subpart P. There are three reasons which make it difficult for professional engineers to get involved in job site safety problems:



- 3 -

- Inadequate workmen's compensation coverage and resulting third party suits.
- Lawyers which take on cases for a 50% contingency fee, eliminating all financial risks for those who initiate legal actions.
- Adversary relationships between the parties involved in the excavation process.

My suggestion that there should be a consensus industry standard in addition to Government regulation was strongly endorsed.



UNITED STATES DEPARTMENT OF COMMERCE  
National Bureau of Standards  
Washington, D.C. 20234  
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July 7, 1981

Mr. William Driskill  
Mr. Arthur Schmuhl  
Mr. James Lapping  
Mr. John Ramage  
Mr. Paul Bouley  
Mr. Ronald Stanevich  
Prof. Jack Mickle  
Mr. John Pannullo

Gentlemen:

Attached is a copy of my draft memorandum on the Dallas Workshop. Please send me your comments before August 7. I shall revise the memo after I receive your comments. In particular, I want to make sure there are no inaccuracies and that I didn't fail to address important issues.

Sincerely,

Felix Y. Yonel, Leader  
Geotechnical Engineering Group  
Structures and Materials Division  
Center for Building Technology, NEL

Attachment

cc: Mr. Edward Hayden  
Mr. John Chambliss  
Mr. Paul Henson  
Mr. Clifford Simmons  
Mr. Bill Zoino  
Mr. George Bradberry  
Mr. John Cook



UNITED STATES DEPARTMENT OF COMMERCE  
National Bureau of Standards  
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D R A F T

July 7, 1981

MEMORANDUM FOR Records of the NIOSH Excavation Project

From: Felix Y. Yokel

Subject: Workshop in Dallas, Texas, June 31, 1981

This memorandum is in addition to proceedings which are being prepared by the Dallas AGC and is intended to cover important issues raised in the Workshop as perceived by me.

(1) General: Art Schmuhl in his introduction raised the issue of development of industry recommendation in a Washington, D.C. Workshop after completion of the Regional Workshops. I am very much in favor of such an effort and I think it needs to be undertaken promptly. However, I think that Art's appraisal that this can be accomplished in one Workshop, which is based on the AGC 2-day Workshop we had, is overly optimistic. This time there will be several groups with different views on some issues, and we will have to deal with many important problems that were raised in the Workshops. I think that perhaps, in preparation for such a Workshop, a very small task committee should prepare a revised draft, revise it once more after corresponding with all the industry committee members, and then have a Workshop on the latest draft. This way you can get all the non-controversial issues out of the way before the Workshop, and in the Workshop concentrate on solving the more controversial issues (depth for standard practice, qualified person, sloping provisions, recognition of regional practices, etc.).

My general impression from the Dallas Workshop was that, overall, the concepts in the draft were well received, but several important issues were raised which will require some substantial revisions in the draft. As in the Wisconsin Workshop, a contractor from Illinois expressed the view that the present OSHA provisions should not be changed. While this view is not shared by the vast majority of contractors who responded to NUCA and AGC questionnaires and who were interviewed in the NBS field study, it is based on several legitimate concerns which in my view will have to be carefully addressed. The trench box manufacturers also submitted a statement and expressed disagreement with some of the recommendations, based on technical considerations. The objections will have to be carefully studied. There was some concern about my statement that the scope of the NBS work was confined to the soil classification and to shoring and sloping provisions.

While this is true, I feel that the participants in these Workshops have the knowledge and experience to address all the issues involved and will do so successfully.

(2) Opposition to Change in Existing Provisions: Opposition to a change in the present version of Subpart P was expressed by an Illinois contractor who works primarily on highway projects. This time I gained some insight into the rationale for this position. I noted in my Wisconsin memo that people who tend to agree with our recommendation are less likely to express their opinion in the Workshop than those who oppose certain recommendations. The same thing happened to some extent when we conducted our field study. Almost all the contractors that responded were dissatisfied with Subpart P. However, the responding contractors who now have concern about changes in the existing regulations are more involved in earthwork, wide excavations, borrow pits, etc., where conflicts with OSHA do not normally arise. They are concerned with two issues.

- a. The present provisions have been interpreted in the courts in past litigations. These interpretations by court rulings tell the contractor precisely what he can do. When we now propose to change the wording of many provisions, there will again be uncertainty about their interpretation by the courts, and we will lose the benefit of experience gained in past conflicts.
- b. We merged "trenches" and "excavations". There is now concern that as a result new restrictions will be imposed on excavation work. Part of this problem can probably be resolved by a clear definition of "exposure." However we need to carefully review our new recommendations to make sure that they do not inadvertently result in unnecessary restrictions on excavation work. An example of this, which was noted in the Workshop, would be the application of Section 1926.651(d) to borrow pits.

(3) Use of OSHA Regulations on Federal Projects: It was noted that other Federal Agencies are not bound by OSHA regulations and use their own procedures. This situation can lead to specifications which are difficult to implement while using methods which comply with our recommendations. I am not sure what can be done about that, but the situation could be brought to the attention of the Administration at an appropriately high level by the participating organizations of the Workshops.

(4) Trench Boxes: Trench box manufacturers suggested that the lateral-load requirements for trench boxes should be different from those for shoring. This is based on the contention that a trench box can deflect considerably and in general will not restrain lateral soil movement as much as a shoring system, thus causing the pressure distribution to resemble that acting on a retaining wall. This would make the square pressure diagrams associated with the Standard Practice too conservative. At this time I cannot evaluate the technical merits of this claim in detail, but I have several preliminary thoughts:

- a. In addition to the allowable stress increase for short-term excavation, we also allow a 20 percent load reduction for walas and a 33 percent reduction for sheating. These reductions, which account for arching effects would apply to the horizontal framing members and the skin of a trench box. I wonder if the industry considers taking advantage of these reductions in their analysis.
- b. The trench boxes I saw had about equal stiffness (in terms of lateral displacement characteristics) near the top and bottom. Thus, I cannot see how a trench box could act like a retaining wall, namely rotate inward while the base is fixed.
- c. It is obvious that a trench box permits greater lateral inward displacements of the excavation wall than a shoring system. In granular soils this will result in a reduction in lateral soil pressures. In clays, however, the situation is more complex. Overconsolidated clays such as those in Austin, Texas where we conducted pressure measurements (NBS GCR 80-202) will develop tension cracks upon lateral expansion, resulting in increased lateral soil pressures. It should be noted that Type B soils include clays.
- d. The greatest problem that would arise if stiffness characteristics of shoring systems are considered is complexity (which our recommendations are designed to avoid). Each case would have to be considered on its own merit. Considering the inadequacies and complexities of present models for soil/structure systems and our general lack of data on lateral pressures in shallow braced excavations, it may be difficult to make a convincing case, and detailed analysis would not be much better than an educated guess.
- e. While the proposed square pressure diagrams may be on the conservative sides, the 40 lb/ft.<sup>3</sup> equivalent weight effect is not conservative for medium clays which fall under Type B soils and are the most common soil type.

It may be helpful if ASFE could review this problem. I am very much afraid that we may be creating an albatross as soon as we deviate from the principle of simplicity in the standard practice.

(5) Configuration of Excavations with Compound Slope: Two problems were discussed in conjunction with Figure 2, page 12:

- a. It was suggested to remove the sharp corners in the drawn cross-sections, since these cannot be dug in the field with ordinary equipment. I suggest that we draw broken lines for the idealized cross-section and back these up with solid lines showing more rounded corners.
- b. The bank adjacent to the work area was discussed. In the previous two Workshops there seemed to be a consensus that the height of the bank should be increased to 4 ft. In this Workshop it was suggested to permit a 5 ft. bank for large pipes. In the latter case, worker protection would be derived from the large diameter pipes. I have some problems with the suggestion:

1. If we permit a 5 ft. bank at the bottom of a slope this would be inconsistent with our requirement to limit the height of an unsupported bank in level ground to 5 ft. This inconsistency would inevitably lead to a court challenge of the 5 ft. bank on level ground on the grounds that a higher unsupported bank would provide equivalent stability.
2. I believe that this configuration would be much more hazardous than a 5 ft. bank in level ground, since a much greater quantity of soil would slide into the trench in case of a stability failure.

It should be noted that Section 1926.652(c) in the present provision states that "... the sides of the trench above the 5 ft. level may be sloped to preclude collapse, "it shall not be steeper than 1 ft. rise in 1/2 ft. horizontal." This conflicts with present Figure P-1 and is less conservative than anything we permit in our present proposal. In the Atlanta Workshop, members of the Kentucky AGC suggested that we permit this configuration for Type A soils.

(6) Exit Provisions: It has been suggested that "climbing upon struts" should be recognized as a legitimate means of exit from a trench. My comment on that is that our proposed loading provision for a 240 lb. concentrated load at the center of the strut would provide adequate strength for an emergency exit of a worker whose weight is within the normal range. However, stepping on struts should be prohibited for non-emergency cases, unless a higher design load is used. This exit option should not be permitted for systems, such as the Wisconsin system, if these systems are permitted on the basis of prior use.

(7) Short-Term and Long-Term Excavations: Several participants suggested to drop the distinction between short- and long-term. It was noted that manholes frequently remain open for 2-3 weeks. I have some problems with this suggestion:

- a. It may force us to do away with Type A soil, the way California did. This would impose economic penalties on some regions.
- b. It may force us to drop the 33 percent overstress. This in turn would cause us to require wooden struts which are heavier than those commonly used (now we come out about right).
- c. The proposed compound slopes (Figure 2) are questionable for long-term use.

The problem may be that our definition of short-term, which is independent of site conditions, may be too simplistic. It was for instance pointed out that in New Mexico, Arizona, and some parts of California and Texas, where there is no rain for long periods of time and no other erosive effects there is really no difference between the short-term and long-term condition. I think that this statement is only partially valid. It is for instance not valid for overconsolidated clays which are common in semi-arid regions.

(8) Depth to Which Standard Practice Applies: Opinions were split between AGC (24 ft.) and AFL-CIO (15 ft.) as in the previous Workshops. An additional rationale was advanced for the 24 ft. depth.

24 ft. is a practical limit for the reach of backhoes. Thus work methods for greater depth will be different.

Some sentiments were expressed for a more restrictive limit for Type C soils.

(9) Engineer vs. Qualified Person: It seems that the AGC group in this region are particularly strong supporters of the use of the term "qualified person." This may have something to do with regional work practices. Two pertinent comments were made:

- a. It was noted that neither a Federal regulation nor a standard can force people to be ethical. If somebody wants to let an unqualified person design his shoring he may do so regardless of provisions.
- b. It was suggested that if we require an engineer in Section 1926.652(a)(2)b, it should also be required that shoring and underpinning be a bid item and thus part of the plans and specifications. I think that, while this is a good idea, OSHA does not have the authority to enforce such a requirement.

I believe that at the core of this controversy is that AFL-CIO would like to have some way by which they can determine if a person is qualified. Perhaps this could be accomplished by a better definition.

(10) Maximum Allowable Slope: It was pointed out that there are gypsum and caliche formations which stand safely at a 1/4 in 1 slope. This raises again two questions: Can our definition of unfractured rock be improved? - It was suggested in this Workshop that perhaps the "competent person" should determine when rock is unfractured. This is probably a good idea as long as there is no dispute. If there is a dispute, we would still have to go back to a precise definition. The other issue is "maximum allowable slope." I do not really believe, that if we go to a quantitative definition (as we have now) it is reasonable to permit slopes steeper than 1/2 in 1. This could conceivably be combined with regional approval of steeper configurations by a "grandfather clause" (see Wisconsin memorandum). The other way would be to allow the "stable slope" concept - this is opposed by the AFL-CIO.

(11) Section 1926.651(e): It was suggested that this section is redundant and should be eliminated.

(12) Section 1926.651(i): The requirements in this section received some discussion:

- a. It was pointed out that these are the requirements for confined space and that there perhaps should be referenced.

- b. It was noted that there were some meetings with OSHA in which modifications in this section were discussed. These modifications did not make their way into our draft. (I never heard about them.)

(13) Section 1926.651(o): It was suggested that this section not be eliminated from Subpart P. It was further noted that the requirements for a harness is in some instances counterproductive since harnesses do not work very well and other protective measures are frequently used. I hope that specific recommendations for re-wording will be made.

(14) Section 1926.651(s): Trench box manufacturers suggested modifications in this section.

(15) Section 1926.651(t): It was noted that the requirements in this section do not apply to many shoring systems. It was suggested to eliminate this section. I would recommend that we try to rewrite the section to simply require that workers engaged in the removal of shoring be not exposed to mass movement of soil or rock from banks where shoring was removed.

(16) Figure 3: It was suggested to eliminate the projection of the shoring above the top of the bank, as this is not always the method used to protect workers from rolling objects.





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July 13, 1981

Mr. Paul Hanson  
Mr. Arthur Schmuhl  
Mr. James Lapping  
Mr. John Ramage  
Mr. Paul Bouley  
Mr. Ronald Stanevich  
Prof. Jack Mickler  
Mr. John Pannullo

Gentlemen:

Attached is a copy of my draft memorandum on the San Francisco, California Workshop. Please send me your comments before August 14. I shall revise the memo after I receive your comments. In particular, I want to make sure there are no inaccuracies and that I didn't fail to address important issues.

Sincerely,

Felix Y. Yokel, Leader  
Geotechnical Engineering Group  
Structures and Materials Division  
Center for Building Technology, NEL

Attachment

cc: Mr. William Driskill  
Mr. Bruce Summers  
Mr. Edward Hayden  
Mr. John Chambliss  
Mr. Clifford Simmons  
Mr. Bill Zcino  
Mr. George Bradberry  
Mr. John Cook  
Mr. James Kleinfelder



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D R A F T

July 13, 1981

MEMORANDUM FOR Records of the NIOSH Excavation Project

From: Felix Y. Yokel

Subject: Workshop in San Francisco, California, July 9, 1981

This memorandum conveys my personal notes and comments relating to the California Workshop. In this instance, it is not clear whether AGC will produce a detailed Workshop report. However, participants have been requested to submit their comments in writing. These comments will be compiled in one document.

(1) General: The California Occupational Safety and Health Standard Board recently prepared a new draft standard for excavation, trenches and earthwork (see Attachment), which seems to be acceptable to the affected parties. It was the understanding of the Workshop participants that the Standards Board delayed adoption of this draft standard until Subpart P is revised. There are similarities between the underlying philosophies of our draft and the proposed California Standard, however there are considerable differences in the substance of these documents. Many of the suggestions made were in the direction of trying to eliminate some of the differences between the proposed California Standard and our proposed standard - generally suggesting that our draft, rather than the California draft, be changed.

In general, California contractors seem to favor a much more conservative practice than contractors in other parts of the country. This trend manifests itself in comments on depth limits for the Standard Practice, allowable slopes and compound slopes, allowable stresses and soil classification (as perceived by the participants). One of the reasons for this approach is the widespread use in California of a contract bid item covering shoring. Such a bid item seems to somewhat reduce the incentive for trying to cut the shoring costs resulting from safety regulations. Most of the participants suggested that OSHA require inclusion of shoring as a bid item in construction contracts. I indicated that I would favor such an approach, but that it is my understanding that OSHA does not have the authority to enforce such a requirement. Before discussing detailed comments, I want to briefly discuss some of the differences between our draft and the proposed California Standard.

- A. Excavation and Trenching: In the present version of Subpart P, excavation and trenching are covered in a redundant fashion. In our proposed revision of Subpart P, the distinction between excavations and trenches is eliminated, and instead we distinguish between short- and long-term excavations. The applicability of some of the requirements to excavations can also be further limited by better defining exposure. In the proposed California draft there are

requirements which apply to both excavations and trenches, and then additional requirements for trenches only.

While the California draft eliminates the redundancy resulting from separate requirements for trenches and excavations, it does not fully eliminate the problems associated with the definition of a trench.

- B. Soil Classification: We introduced a simple soil classification with three soil types - hard and compact, medium, and saturated soft and submerged. The proposed California Standard has two soil classes: "hard compact" and "running." Running soils are defined as: "Earth material whose angle of repose is approximately zero, as in the case of soil in a nearly liquid state, or dry, unpacked sand which flows freely under slight pressure. Running material also includes loose and disturbed earth that can only be contained with solid sheeting" (the last sentence was added recently).

The proposed California classification is based on a recent Stanford University study which I did not see. All earth that is not "running" is "hard compact." The lateral pressures associated with these soil classes are not explicitly defined. Rather, there are prescriptive tables for wood, aluminum pipe and hydraulic systems, and steel pipe and hydraulic systems. However, on Page 26, Plate C-22, which is addressed to engineers, it is stated that "A minimum coefficient of active earth pressure of 35 pcf (KW=35) shall be used in all calculations unless a soil evaluation indicates otherwise."

Normally the "coefficient of active earth pressure" is dimensionless, so I assume that 35 pcf represents the product of the coefficient and the unit weight of the soil. Whether it is suggested to also use a square pressure diagram of 0.8KW as stipulated in the present California Standard is not clear. There is no specific guidance for "running" soils.

I did some back calculating from the proposed table, using the allowable timber stress of 1300 psi - 20 /d which is stipulated on Page 14, and got minimum distributed pressures of about 40 pcf for the compact soil, and about 68 pcf for the running soil, with most member sizes much more conservatively designed. (The equation proposed for allowable timber stresses is no longer used in timber engineering practice. Allowable stresses come out much higher than those we propose for hardwood, though they may be O.K. for stress graded softwood.)

I have some problems with the proposed California classification: as far as I can see, "running" soil would include muck, dry and submerged sands and probably other dry and submerged cohesionless soils including fill, and possibly some very fissured and very soft clays. "Hard compact" soils would include all but the very soft intact clays and a great many fissured clays which can be contained by spaced sheeting, and probably many moist cohesionless materials. Hydrostatic conditions are not mentioned.

This leaves me confused. You could have a soft clay under "hard and compact" (as long as it has enough cohesion to stand up temporarily to the bottom of the excavation) and a dry sand under "running." Yet the clay will develop high lateral pressures while the sand would develop very low pressures. Thus, while it is probably true that a man in the field could relatively easily identify "running" soils, the soils do not seem to be sorted out with respect to anticipated lateral pressures and stable slopes.

There is no one-to-one correspondence between our "hard and compact" soils and the "hard compact" soils proposed for the California classification, even though I sense that some of the Workshop participants may have had that perception. Considering the wide range of soils that could fall within this category, the 40 pcf I calculated for the table may be on the low side (California "hard compact" soils could include soft clays). Our "Type A" soils are not broken out in this classification, but some of our Type B soils are thrown into "running" (the dry cohesionless soils) and some of our Type C soils are thrown into "hard compact" (the soft clays). I believe that if we do insist having only two soil classes, a more logical split would be obtained by putting Type A and B together and leaving Type C soils as we now define them.

Another significant feature of the proposed California system is that our Type A soils are not broken out as a category. Their 35 pcf minimum "KW" is an indication of that. I was aware that the lateral pressure presently stipulated in the California Standard for "hard compact" soils were deemed inadequate in the "California Trenching and Shoring Manual" (Caltrans). If we were to likewise eliminate Type A soils on a nationwide basis, many shoring systems presently successfully used would be deemed inadequate.

Somehow the proposed California classification conveys the impression that soils which will stand vertically when you dig require less shoring. If we take for instance a clay that would stand up in a 12 ft. cut, its cohesion would be about 300 lb/ft.<sup>2</sup>. This is a soft clay, which according to what we know could develop a very high lateral pressure, certainly much higher than that of a dry sand. Yet the clay would be classified as "hard compact" in the California scheme if the trench dug is less than 12 ft. deep. In our classification it would be Type C.

In closing, I would like to note that the present California Standard contains a soil classification which is very compatible with the one we are proposing and which to my knowledge has a successful 20 year track record.

- C. Shoring System Selection: As I already noted, the proposed California Standard stipulates specific shoring systems. Such an approach may be attractive for our standard practice, and could be accomplished in an Appendix. However, it would be probably impossible to do this for timber shoring on a nationwide basis. We also would have to make sure that all existing and potential future systems get equal consideration.

(2) Qualified and Competent Person: Several contributions were made to this controversy: ASFE suggested that it be required that the qualified person, when designing shoring, should submit calculations. This would put him on the spot when something happens. But it would only reveal deficiencies before an accident if some kind of peer review is used. Peer review is now successfully used with ASFE. California AGC proposed to require that the qualified person be "designated by the contractor." This would make the contractor responsible for the competence of the person. California AGC also proposed to eliminate the competent person and use only qualified persons for everything. It seems that both the ASFE and the AGC suggestions contain concepts which would improve our definition. Another interesting and important point was made by the Oregon AFL-CIO: a "qualified person" from Montana was in charge of an excavation in Oregon. The excavation in Oregon collapsed, because the man was not familiar with local conditions. This perhaps underscores the importance of assigning responsibilities to the contractor which was stressed by the California AGC.

(3) Depth Limitation of Standard Practice: California AGC supports 20 ft. - as in the California Standard. A representative of the American Gas Association (AGA) noted that backhoes in his area have a depth reach of about 20 ft. and not 24 ft. as was noted in Texas.

(4) Accidents: A representative from Liberty Mutual noted that he has no record whatsoever of fatalities in shored excavations. Some of the participants noted that they are aware of such cases. I pointed out, that even though our evidence tends to indicate that many of the collapsed trenches were not shored, we looked at two cases of fatalities in improperly shored excavations during our study.

(5) Allowable Slopes: California AGC suggested that the compound slope case shown in Figure 2, Case IV should be limited to 12 ft. depth in hard compact soils (California definition) and shown as in the California Standard. It was also noted that a California study shows that the bank next to the work area in Case III would be safe at 4 ft. depth. I have no problems with these suggestions (except that we do not have the California "hard compact" category), except perhaps that they may be too restrictive. They are based on a study by R. T. Frankian and Assoc. (see Attachment). The concept used in this study was that of equivalency to an unsupported 5 ft. deep vertical bank. Such a bank would "just stand up" in a very soft clay with cohesive strength of only 150 pcf - a very soft soil indeed, which is only rarely encountered. For such a soil, if it can be sloped at all, our allowable slope would be only 1-1/2 to 1, a very flat slope. Our proposed compound slopes in Figure 2 are based on a somewhat different set of assumptions: equivalent stability to a sloped trench for whatever the depth of the trench happens to be. Of course many of our Type B soils will not stand with an unsupported bank of any depth, since they would be "running" by the California Standard.

Another point that was made was that our steepest allowable slopes in Table 1 are not necessarily stable for the soil type in all cases. This is correct, and that is the reason why I have trouble with dropping the "stable slope" concept. It is not practical to come up with slopes which would be stable for all cases. What we have now is maximum allowable slopes which should not be exceeded without an engineering study.

(6) Short-Term and Long-Term Excavations: California AGC suggested to drop the distinction. Similar suggestions were made in other Workshops. The problem I have with those suggestions is that they would force us to increase the safety margins. But if we increase those by much we will end up with a scheme which is much more conservative than what we now consider good practice. One interesting suggestion that was made is that a reassessment of shoring in a long-term situation could be made whenever people are exposed.

(7) Local Options: It was stressed that any National Standard should be flexible enough to accommodate local options. As I stated in my previous memoranda, I strongly recommend that we have a mechanism by which we can permit local options with proven track records which deviate from the "Standard Practice."

(8) Excavation Below Bottom of Shoring or Trench Box: The California groups tend to support the 2 ft. limit we have, which is also in the California Standard. This again is an indication of the conservatism of the California AGC. It also may be related to work methods.

(9) Section 1926.651(d): Add "... water shall not be allowed to accumulate in an excavation while work is in progress ..."

(10) Section 1926.651(e): "... the side of the excavation shall be shored ..." is too restrictive. Other methods may be used. Also Section is considered redundant altogether.

(11) Section 1926.651(g): Should be eliminated, or perhaps changed to proposed California provision.

(12) Section 1926.651(h): "remotely located" should be eliminated.

(13) Section 1926.651(k): There should be a height limitation. In the proposed California Standard it is 7-1/2 ft. (no reason for height was suggested).

(14) Section 1926.651(k): There should be a general requirement for good access like in the California Standard.

(15) Section 1926.651(i): Should perhaps be eliminated.

(16) Section 1926.651(e): It is suggested that the California Standard has a better formulation. However the problem of defining "vibration" which was noted in Texas is not solved in the proposed California Standard either.

(17) Section 1926.651(h): There should be rather a performance requirement for protecting workers against falling into a trench.

(18) Section 1926.651(g): It was strongly suggested to eliminate this statement.

(19) Section 1926.652(b)(4)(if): Should be in an appendix or in the definitions.

(20) Section 1926.652(b)(4)(i): Was considered perhaps too complicated

(21) Section 1926.652(b)(5)(i): Option should be provided to "block off" the intercepting trench with shoring.

- (22) Section 1926.653(g): Authorized by whom?
- (23) Section 1926.653(h): Engineer should be "Civil."

Attachments

**R. T. FRANKIAN & ASSOCIATES**

*Theoretical and Applied Earth Mechanics*

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January 10, 1977

Associated General Contractors  
of California  
Safety Committee  
c/o Granite Construction Company  
P.O. Box 900  
Watsonville, California 95076  
Attention: Mr. Bruce G. Summers, Chairman

Gentlemen:

Transmitted herewith are ten copies of our "Study to Determine Compound Slopes Equivalent to CAL-OSHA Allowable Unshored Slope," dated January 10, 1977.

This study was planned in consultation with Mr. Summers and Mr. J. M. Lyles.

It is the conclusion of this study that when the total depth of the excavation does not exceed 8 feet, a 3/4 horizontal to 1 vertical slope with a 3 1/2-foot vertical cut at the toe, is equal and equivalent in stability to a 5-foot high vertical slope. The same condition exists for cuts up to 12 feet in total height when the gradient of the slope above a 3 1/2-foot vertical cut is 1 to 1.

Should you wish to discuss the study further or have any questions, please do not hesitate to call.

Yours very truly,

R. T. FRANKIAN & ASSOCIATES

  
Kenneth S. Pitcher  
Civil Engineer 24232

  
R. T. Frankian  
Civil Engineer

KSP/RTF/rk (10)



STUDY TO DETERMINE COMPOUND SLOPES THAT ARE  
EQUIVALENT TO CAL-OSHA ALLOWABLE UNSHORED SLOPES

INTRODUCTION

The purpose of this study is to determine which unshored configurations of compound slopes would possess stabilities equal and equivalent to the stability of either a 5 foot high vertical or a 12 foot high  $3/4$  to 1 unshored slope, as allowed in the CAL-OSHA Construction Safety Orders. The 5 foot vertical and the  $3/4$  to 1 slopes are plain, that is, consist of a single, unbroken slope face. The compound slopes reported in this study consist of a vertical cut at the toe of an inclined plane.

This study is limited to soils which possess strengths sufficient to stand at those configurations permitted by the CAL-OSHA standards. Consideration of clean, running sands, saturated sands, and other soils which would not be stable on a 5 foot high vertical slope have been eliminated from this study.

#### BASIS OF ANALYSIS

The analysis began with the determination of those strengths which are required for the stability of the plain 5 foot vertical slope and the 12 foot high 3/4 to 1 plain slope. The method of analysis was that commonly used and referred to as the slip circle method. The analysis included consideration of a variety of tension crack locations and calculations were extended until the most critical combination of slip circle and tension crack was obtained.

It was found that the 5 foot high vertical slope was more critical than the 12 foot high 3/4 to 1 slope, that is, the 5 foot high slope would require soil strengths ~~less~~ than the strengths required to maintain the same degree of stability for the 3/4 to 1 slope. For purposes of this report we will refer to the 5 foot vertical slope as the standard slope, since it is that slope which will set the standard for stability of the compound slopes.

Starting with the strengths which were required for stability of the standard slope a variety of compound slopes were analyzed, each with an entire new series of trial slip circles for each configuration. Each of the calculations included consideration of the most critical location for a tension crack. Thus for each total slope height (depth of trench) one specific configuration was obtained which would possess a stability equal and equivalent to the stability of the standard slope.

Equivalent stability is defined by means of the ratio of the soil resistance available ( $S_a$ ) as determined from the standard slope, to the soil resistance required ( $S_r$ ) to provide stability for the compound slope. When  $S_r$  is equal to  $S_a$ , that is, when the resistance required is equal to the resistance available, the compound slope would have a stability equal and equivalent to the standard slope.

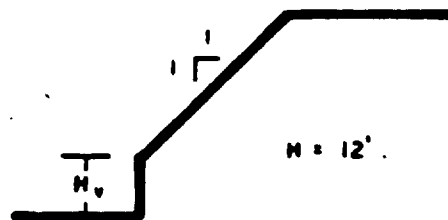
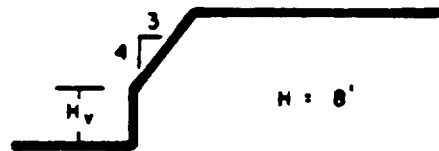
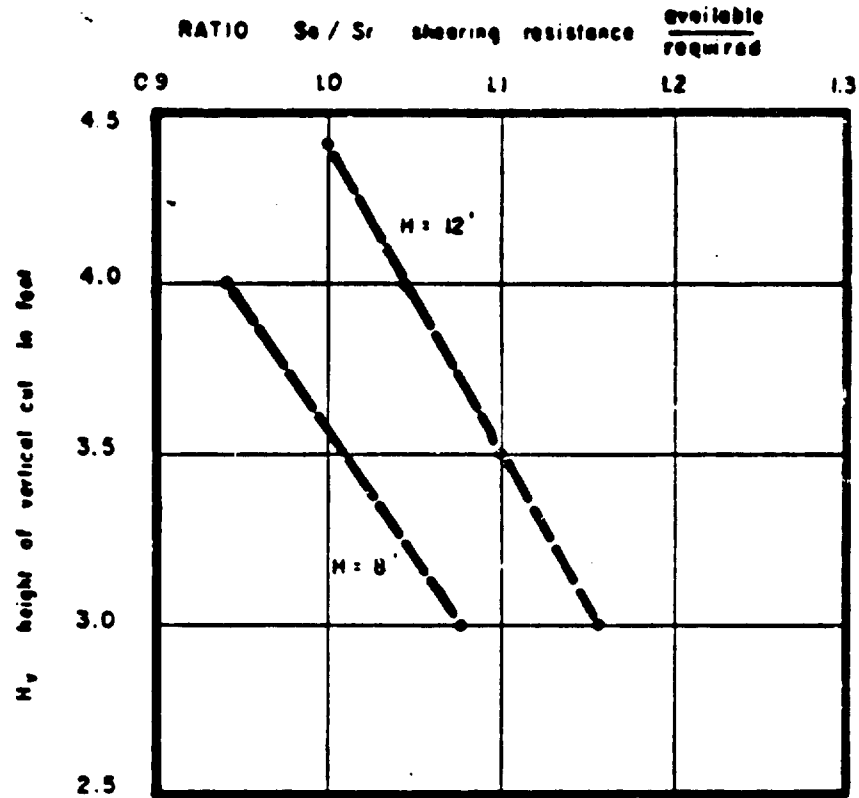
Other ratios of  $S_a/S_r$  may be considered, and where the same ratio occurs between a compound slope and the standard slope, it can be stated that the stabilities of these two slopes are equal and equivalent.

#### RESULTS OF ANALYSIS

Calculations were made for compound slopes with overall heights (depth of trench) of 8 feet and 12 feet. For both 8 and 12 foot slopes the gradient of the upper portion of the slope was varied and the height of vertical toe was varied. The results of the calculations for the final configurations are presented on the following pages.

Where the height of the vertical portion of the slope at the toe is  $3\frac{1}{4}$  feet, the stability of the 8 feet high slope is equal and equivalent to the standard slope when the upper portion of the slope is inclined at  $3/4$  to 1.

Where the height of the vertical cut is again  $3\frac{1}{4}$  feet and the overall height is 12 feet the stability of this configuration is at least equal and equivalent to the standard slope when the upper portion of the slope is inclined at 1 to 1.



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The effect of water collected in the most critical tension crack has also been investigated. If it is assumed that the critical tension crack for the standard slope is filled by water and calculations are made on the affect of water filling the most critical tension crack of any of the compound slopes, the ratio of  $S_a$  to  $S_r$  for the compound slope is greater than unity, that is, the compound slope possesses a stability at least equal to that of the standard slope.

#### CONCLUSIONS

If the total depth of the cut does not exceed 8 feet, the stability of a  $3/4$  to 1 slope with the lower  $3/4$  feet cut vertically is equal and equivalent to the stability of a 5 foot high vertical cut excavated in the same soil.

If the total depth of the cut does not exceed 12 feet, the stability of a 1 to 1 slope with the lower  $3/4$  feet cut vertically is at least equal and equivalent to the stability of a 5 foot high vertical cut excavated in the same soil.

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The following Plates are attached and complete this report:

Sample Calculations

Respectfully Submitted,

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### SAMPLE CALCULATION

PAGE 1

ESTIMATE GRAVITY RESISTANCE BASED ON TO PROVIDE GRAVITY FOR A 2 FT HIGH CURB WITH A VERTICAL, USE UNIT SOIL WEIGHT,  $\gamma$ , OF 120 POUNDS / FT<sup>3</sup>.

THE TWO ABOVE METHODS OF ANALYSIS, BASED ON CENTER OF MASS CRITICAL  
EARTH IS A FUNCTION OF SOIL COMPOSITION AND SOIL COMPOSITION,  $\rho$  AND  $C$ .  
OF THE TWO METHODS OF ANALYSIS, BASED ON CENTER OF MASS CRITICAL  
COMPOSITION IN SOILS,  $\rho$  AND  $C$  IS THE UNIT

FOR PLAIN OR SIMPLE SLOPS THE LOCATION OF THE SIGN OF THE MOST CRITICAL SLOP ANGLE MAY BE OBTAINED FROM SIMILARITIES PRESENTED GENERATED BY JANUS (SEE NAV-DECS DM-7).

$\lambda_{0f} = \frac{1}{\mu_0} \cdot \tau_{0f} \cdot \phi / C$

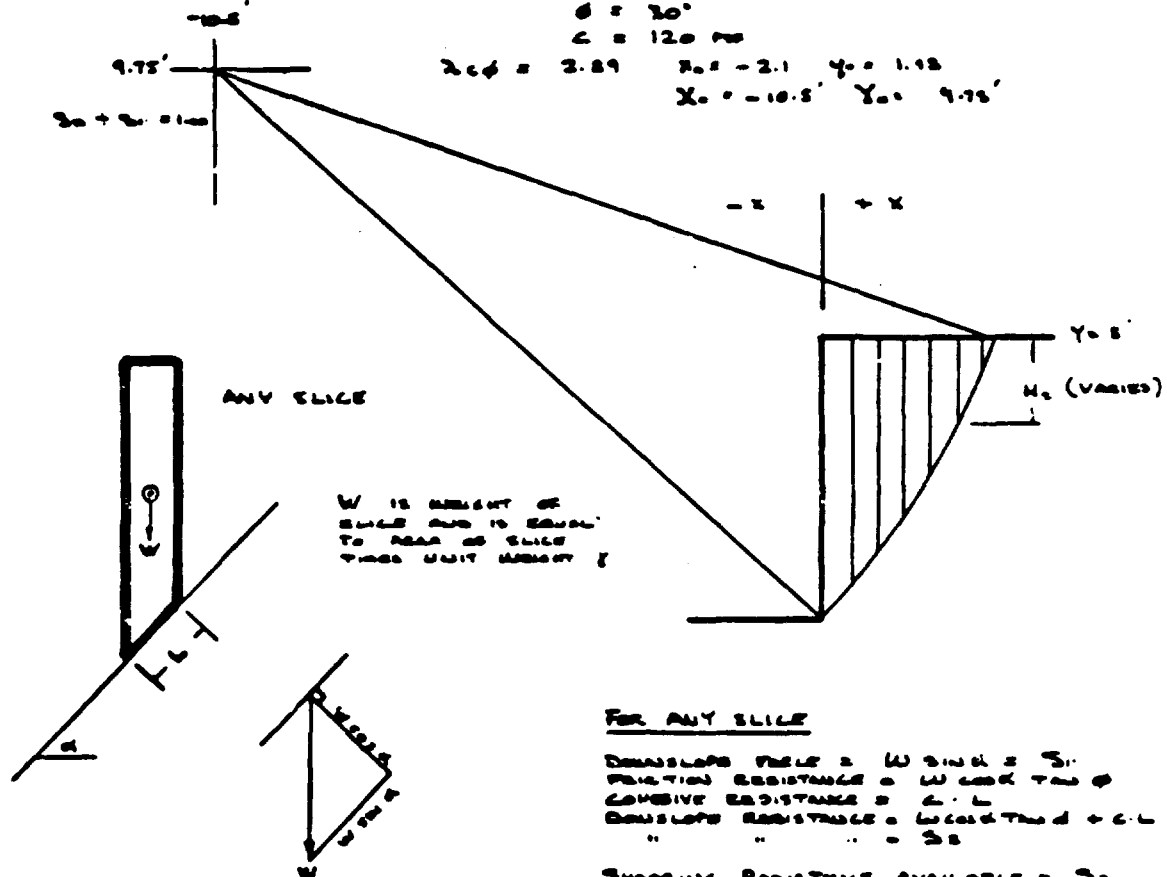
Assume  $H = 5$  FEET (SLOPE HEIGHT)

6 8 20'

$C = 120$  Pcs

$$\lambda_{cp} = 2.29 \quad \pi_{\infty} = -2.1 \quad \gamma_{\infty} = 1.92$$

$$\lambda_{\infty} = -10.5 \quad \gamma_{\infty} = 9.75'$$



FOR ANY SLICE

DOWNSLOPE PILE 2 (1)  $\sin \alpha = 51$   
 FRICTION RESISTANCE =  $W \cos \alpha \tan \phi$   
 COHESIVE RESISTANCE =  $c \cdot L$   
 DOWNSLOPE RESISTANCE =  $W \cos \alpha \tan \phi + c \cdot L$   
 " " " = 38

SHOULDER RESISTANCE AVAILABLE = 32  
SHOULDER RESISTANCE REMAINING = 34

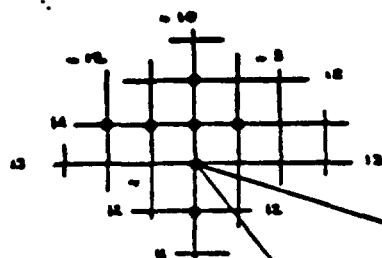
FOR EACH SLICE CALCULATE  $S_1$  AND  $S_2$ . COLLECT SUM OF THESE VALUES FOR ALL CASES OF VARIABLE TENSION CRACK LOCATIONS. FOR EACH CALCULATION EXCLUDE THOSE SLICES TO RIGHT OF THE TENSION CRACK SELECTED. OBTAIN CONSIDERATIONS WHICH WILL PRODUCE LOWEST VALUE OF THE RATIO OF  $S_2 + S_1$ .

SOIL STEADFAST WHICH PRODUCE MINIMUM 52.4% OF SWIFT RES  
THE STEADFAST WHICH REPRESENT STABLE STEADFAST SLOPE.

# SAMPLE CALCULATION

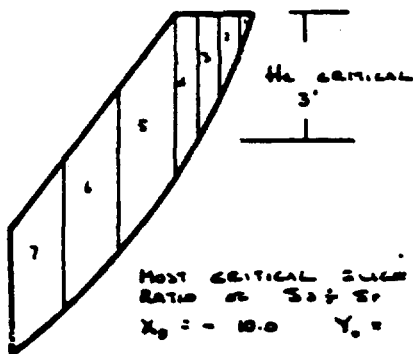
PAGE 2

DETERMINE MINIMUM VALUE OF THE RATIO OF SLICING RESISTANCE AVAILABLE  $S_2$  TO SLICING RESISTANCE REQUIRED BY FOR ANY PRELIMINARY COMPOUND SLOPE



CONSTRUCT COMPOUND SLOPE WITH OVERALL HEIGHT OF 8 FEET AND VERTICAL CUT  $H_v$  OF 3 FEET. SLOPE ANGLE  $\beta = 93^\circ$  (3/4/1)

CONSTRUCT SERIES OF SLIP CIRCLES--VARY DEPTH OF TENSION CRACK FOR EACH TRIAL SURFACE.



MOST CRITICAL SLIP FORMED BY MINIMUM RATIO OF  $S_2 \div S_1$   
 $X_0 = -10.0$   $Y_0 = 13.0$

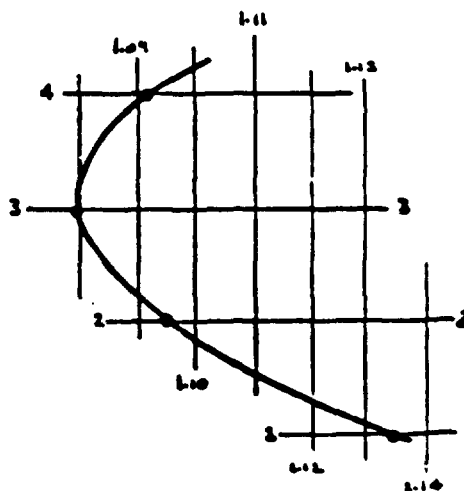
RATIO  $S_2 \div S_1$

CALCULATE STABILITY IN TERMS OF RATIO OF  $S_2 \div S_1$  (SEE PREVIOUS PAGE)

EFFECT OF TENSION CRACK IS TO ELIMINATE THOSE SLICES TO THE RIGHT OF CRACK LOCATION, E.G. FOR TENSION CRACK 3' DEEP--CALCULATE  $S_2 \div S_1$  FOR SLICES 4 THRU 7

MINIMUM  $S_2 \div S_1$  OCCURS AT CONFIGURATION  $X_0 = -10$   $Y_0 = 13$  AND  $H_v = 3$  FEET. RATIO IS 1.078 THIS REPRESENTS ONE POINT ON GRAPH PRESENTED IN TEXT.

TENSION CRACK DEPTH



**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Amend the definition of Excavation, Trenches, Earthwork in Section 1504 to read:

**Excavation, Trenches, Earthwork.**

(A) Bell Bole. An additional excavation made into the sides or bottom of a trench to provide additional work space.

(B) Balled Excavation. A part of a shaft or footing excavation, usually near the bottom and bell-shaped, that makes the cross-sectional area at that point larger than that above.

(C) Braces for Excavations. The horizontal members of the shoring system whose ends bear against the uprights or stringers.

(D) Earthwork. The process of excavating, moving, storing, placing, and working any type of earth materials.

(E) Excavation. A man-made cavity or depression in the earth's surface, including its sides, walls, or faces formed by earth removal and producing unsupported earth conditions by reason of the excavation. If installed forms or similar structures reduce the depth to width relationship, an excavation may become a trench.

(F) Hard Compact. All earth material not classified as running. or-unstable

(G) Qualified Person. A person designated by the employer who by reason of experience or instruction is familiar with the operation to be performed and the hazards involved.

(H) Running. Earth material whose angle of repose is approximately zero, as in the case of soil in a nearly liquid state, or dry, unpacked sand which flows freely under slight pressure. Running material also includes loose or disturbed earth that can only be contained with solid sheeting.

(I) Shaft. An excavation under earth's surface whose depth, either horizontal or vertical, is much greater than its cross-sectional dimensions such as those formed to serve as wells, cesspools, certain foundation footings, and under streets, railroads, buildings, etc.



## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

(J) Sheet Pile. A pile, or sheeting, that may form one of a continuous interlocking line, or a row of timber, concrete, or steel piles, driven in close contact to provide a tight wall to resist the lateral pressure of water, adjacent earth, or other materials.

(K) Shore (Strut). A supporting member that resists a compressive force imposed by a load.

(L) Shoring System. A temporary structure for the support of earth surfaces formed as a result of excavation work.

(M) Sides, Walls, and Faces. The vertical or inclined earth surfaces formed as a result of excavation work.

(N) Sloping of-Berth. The angle with the horizontal which a particular earth material will stand indefinitely without movement. A method of excavation whereby the faces of an excavation or trench are laid back to provide protection from moving ground.

(O) Spoil. The earth material that is removed in the formation of an excavation.

(P) Stringers. The horizontal members of the shoring system whose sides bear against the uprights or earth.

(Q) Trench. Shall mean an excavation in which the depth exceeds the average width of its cross-section. Excavations that are more than 15 feet wide at the bottom, shafts, tunnels, and mine excavations are not trenches. A narrow excavation made below the surface of the ground. In general, the depth is greater than the width at the bottom, but the width of a trench at the bottom is not greater than 15 feet.

(R) Trench Jack. Screw or hydraulic type jacks used as cross bracing in a trench shoring system.

? (S) Trench Shield. A shoring system generally composed of steel plates and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom of which can be moved along as work progresses. NO

(P)--Unstable, as used in Article 6,--Earth material other than running that, because of its nature or the influence of related conditions, cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.

(T) Uprights. The vertical members of the shoring system.

(U) Waler. A structural member in a horizontal or nearly horizontal position used for stiffening or securing other components of concrete forms, excavation sheeting, or similar temporary structures.

**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Adopt new Section 1540 to read:

**1540. Excavations.**

(a) Scope. Sections 1540(b) through (n) and 1541 apply to all excavations, trenches, shafts or earthwork and establish essential requirements and minimum standards of safety in earth excavation work.

NOTE: (1) Whenever the term "excavation(s)" is used it also applies to trenches, shafts and other earthwork.

(2) For additional shaft and incline excavation details, see Sections 1542 and 1543.

(3) For additional earthwork excavation details, see Sections 1544 through 1547 which apply to such work locations as borrow pits, road or dam construction sites and similar work areas.

(4) The Orders in this Article do not apply to work covered by the Mine Safety Orders or the Tunnel Safety Orders.

**(b) Preparations.**

(1) Prior to opening an excavation, the employer shall determine whether underground installations such as, sewer, water, fuel, electric lines, telecommunication lines, etc., will be encountered, and if so, where such underground installations are located.

(2) When the excavation work approaches the approximate crossing or parallel location of such an underground installation and danger of accidental contact or disturbance is possible, the exact location shall be determined by appropriate means before proceeding. When it is uncovered, adequate protection shall be provided for the existing installation.

(3) All known owners of underground facilities in the area involved shall be advised of proposed work at least 48 working hours prior to the start of excavation work.

Exception: Emergency repair work to underground facilities.

(4) Trees, boulders, poles and other surface encumbrances located so as to create a hazard to employees involved in excavation work, or in the vicinity thereof at any time during operations, shall be removed or made safe before excavating is begun.

CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD(c) Exposure.

(1) No employer shall cause or permit his employees to work in or adjacent to any excavation until a reasonable examination of same has been made by a qualified person to determine that no recognizable conditions exist exposing them to injury from possible moving ground.

(2) Excavations shall be inspected by a qualified person after every rainstorm or other hazard-increasing occurrence and the protection against slides and cave-ins shall be increased, if necessary, before employees are permitted to enter the excavation.

(d) Protection. Employees who must enter excavations 5 feet or more in depth shall be protected by a system of shoring, sloping of the ground, benching, or other effective means as provided by these Orders. Protection for employees who must work in excavations less than 5 foot in depth shall also be provided when examination by a qualified person indicates that hazardous ground movement may be expected.

(e) Spoil.

(1) Excavated material shall be prevented from falling back into the area where employees are working. This shall be done by locating the spoil at a distance from the edge of the excavation consistent with the character of the material and the nature of the operations, but unless otherwise contained, in no case shall be excavated material be placed closer than 2 feet from the edge of excavations.

(2) No method that disturbs the soil that is in place (such as driving stakes) shall be used to contain the spoil material.

(f) Supervision. Excavation work and work in an excavation shall at all times be under the immediate supervision of someone with authority and qualifications to modify the shoring, sloping or other system or work methods as necessary to provide greater safety. Such modification shall not permit the specific dimension requirements of other Orders to be less restrictive than shown except as permitted by Section 1541(a)(6). This person shall examine the material under excavation and improve the shoring or other methods beyond the minimum requirements, as necessary, to insure protection of workers from moving ground.

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

(g) Access.

or NEARLY  
SLOPE, (FED. MAP)

(1) A convenient and safe means of access shall be provided for employees to enter and leave an excavated area. This shall consist of a stairway, ladder or ramp securely fastened in place at suitably guarded or protected locations where employees are working.

(2) When employees are required to be in trenches 4 feet or more in depth, a safe means of access shall be provided and located so as to require no more than 25 feet of lateral travel.

Exception: In utility trenches less than 5 feet in depth, earth ramps or steps are acceptable provided that they are not more than 75 feet on centers.

(h) Crossings.

(1) Trenches shall be crossed only where safe crossings have been provided.

(2) When walkways or bridges are provided across excavated areas, they shall be provided with standard guardrails and toeboards when the depth of excavation exceeds 7-1/2 feet.

(i) Excavators. An employee working in the vicinity of operating excavating equipment shall be required to work in a safe position such that the employee is not in danger of falling into or otherwise contacting the machine's moving parts.

(j) Undermining.

(1) No excavation work shall take place below the level of the base of an adjacent foundation, retaining wall or other structure until it has been determined by a qualified person that such excavation will in no way create a hazard to workers or until adequate safety measures have been taken for the protection of workers.

(2) Undermined sidewalks and/or pavements shall be supported to safely carry all anticipated loads.

(3) If the stability of adjoining buildings or walls is endangered by excavations, either shoring, bracing, underpinning, or other method affording equivalent protection for workers shall be provided as necessary to ensure their safety. All such systems shall be inspected daily or more often, as conditions warrant, by a qualified person and the protection effectively maintained.

CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD(k) Retaining Walls.

(1) No existing wall or other structure shall be made by reason of an excavation or backfill, to function as a retaining wall until it has been determined that such wall will safely withstand all expected loads that otherwise might be a source of hazard to workers.

(2) Wherever a permanent retaining wall, in lieu of the temporary shoring system of this Article, is constructed to hold any part of an excavation that might endanger workers, such wall shall be designed and constructed to effectively resist all existing and expected loads. Standards of design shall be comparable to those of the California Administrative Code, Title 24, Building Standards, or any comparable local building code of equal or greater restrictiveness.

(l) Barriers at Unattended Work Locations.

(1) Means shall be provided to prevent mobile equipment from inadvertently entering excavations.

(2) Adequate physical barrier protection shall be provided to prevent employees from falling into excavations.

(A) All wells, pits, shafts, caissons, etc., shall be barricaded or securely covered.

(B) Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc., shall be backfilled.

(m) Water Accumulation.

(1) Diversion ditches, dikes, or other effective means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation.

(2) Accumulations of water in excavations which endanger the stability of those excavations or pose a hazard to employees shall be controlled before further work progresses.

(n) Vibrations or Superimposed Loads. Special safety provisions consisting of additional bracing or other effective means shall be taken at excavations adjacent to streets, railroads, or sources of external vibrations or superimposed loads. Similar provisions shall be taken in excavations made in areas that have been previously filled.

**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Adopt new Section 1541 to read:

**1541. Shoring, Sloping and Benching Systems.****(a) General.**

(1) All materials of the shoring system used in complying with the provisions of this Article shall be free from defects and damage that might in any way impair their protection function.

(2) Where a shoring system is used it shall be designed and installed to sustain all existing and expected loads.

(3) Provisions shall be made by the employer to prevent injury to employees engaged in the installation of shoring for trenches and other excavations. In trench work this may be done by providing and requiring the use of devices that will allow upper cross braces to be placed from the ground surface before employees work in the trench at those points. In deep trenches requiring additional braces, workers shall then progress downward, protected by cross braces that have already been set firmly in place. The reverse procedure shall be followed when removing shoring.

(4) No part of the shoring system of any excavation shall be removed until effective means have been taken to avoid hazards to employees from moving ground.

(5) If a newly installed masonry or concrete wall is to be depended upon for protection against moving ground, it shall have attained adequate strength to sustain resulting pressures before employees are permitted to enter.

(6) If the excavation is deeper than 20 feet or an alternate shoring, sloping or benching system or combination thereof is to be used, a civil engineer, currently registered in California, shall prepare detailed plans showing the materials and methods to be used. See Appendix Plate C-22.

Exception: Sloping or benching as permitted by this Article.

(A) Where alternate shoring, sloping, or benching systems are used, the engineer's detailed plans shall be available for inspection by the Division at the work site.

(B) Employees must be adequately trained in the safety precautions and hazards associated with the alternate shoring, sloping, or benching systems used.

(C) The written Code of Safe Practices required by Section 1509 shall be revised as appropriate to incorporate the engineer's recommendations.

**(b) Standard Shoring System - General.**

(1) Shoring shall be installed in accordance with Tables 1 or 2 of these Orders or as detailed in plans and specifications prepared by a civil engineer currently registered in California. See Appendix Plate C-22 for engineering criteria.

**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

(2) Solid wood sheeting or wood sheet-piling shall be not less than 2-inches in thickness. However, plywood 1 1/8-inch in thickness may be substituted.

(3) Wood uprights shall be not less than 2 inches by 8 inches.

(4) Wood braces and diagonal shores (struts) shall not be less than 4-inch by 4-inch material and not subjected to compressive stress in excess of values given by the following formula:

$$S = 1300 - (20L/D)$$

$$\text{Maximum Ratio } (L/D = 50)$$

Where L = length, unsupported, in inches  
and D = least side of the timber in inches  
S = allowable stress in pounds per  
square inch of cross section.

(5) Diagonal shores (struts) shall be wedged or cleated at the bulkhead end, and, if bearing on the ground, shall not impose loads in excess of test-determined soil-bearing values, or in the absence of test data, those given in Plate C-22 of the Appendix.

NOTE: Allowance should be made for the horizontal component of force.

(6) Diagonal shores (struts) shall not be placed at an angle greater than 45 degrees with the horizontal.

(7) When tie rods are used to restrain the top of sheeting or other retaining systems, the rods shall be securely anchored.

(8) When tight sheeting or sheet-piling is used, full loading due to ground water table shall be assumed, unless prevented by weep holes, drains or other means.

(9) Additional stringers, ties, and bracing shall be provided to allow for any necessary temporary removal of individual supports.

(10) If nonstress grade lumber is used for sheeting and lagging, the following thickness and spacing requirements shall be observed:

Minimum rough thickness  
of sheeting or lagging

2 inches  
3 inches

Maximum spacing  
of shoring

4 feet  
7 feet

(11) All hydraulic shoring systems shall be installed, tested and maintained in accordance with the manufacturers' recommendations or in accordance with good engineering practice.

**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD****(e) Trench Shoring Systems.**

(1) Trench shoring systems shall be installed in compliance with Section 1541(b) and Tables 1 and 2 of this section.

(2) Shoring systems in trenches shall consist of uprights held rigidly opposite each other against the trench walls by jacks or horizontal cross members (braces) and, if required, longitudinal members (stringers/walers) as required in Tables 1 and 2.

(3) Uprights shall be installed parallel with each other.

(4) A shored trench shall not be sloped in excess of 15 degrees from vertical.

(5) Uprights shall not be less than 2 inches in nominal thickness.

Exception: Plywood panels at least 3/4-inch thick may be used behind the uprights in order to hold loose material not likely to impose heavy loads.

(6) Uprights shall extend to at least the top of the trench and to as near the bottom as permitted by the material being installed, but not more than 2 feet from the bottom.

Exception: When running soil is encountered, shoring shall extend to the bottom.

(7) Cross braces shall consist of metal screw-type trench jacks with a foot or base on each end of pipe, or timbers placed horizontally and bearing firmly against uprights or stringers. Hydraulic metal braces may also be used. See Tables 1 and 2.

(8) The minimum number of horizontal braces, either jacks or timbers, required for each pair of uprights shall be determined by the number of 4-foot zones into which the depth of the trench may be divided. One horizontal brace shall be required for each of these zones, but in no case shall there be less than 2 braces. Trenches, the depths of which cannot be divided equally into these standard zones, shall have an extra horizontal brace supplied for the short remaining zone, if such zone is greater than 1/2 the 4-foot unit. In no case, however, shall the vertical spacing of horizontal braces be spaced greater than 4 feet center to center. Minor temporary shifting of horizontal bracing will be permitted when necessary for the lowering of materials into place.

(9) The dimensions and spacing of the elements of the shoring system shall be governed by the depth of the trench, type of soil encountered, and other special conditions of the site, but in no case shall they provide less strength than the members listed in the following tables which are to be considered as a minimum requirement.



TABLE 1  
SMORING FOR HARD COMPACT SOIL

SPACING (ft)	Uprights		Braces								Stringers (Walers)	
	Horizontal Spacing (ft)	Size (in)	Horizontal Spacing (ft)	Wood		Aluminum Pipe and Hydraulic Systems		Steel Pipe and Hydraulic Systems		Vertical Spacing (ft)	Wood Size (in)	
				Size (in)	Max. Trench Width (ft)	Min. Dia. (in)	Max. Trench Width (ft)	Min. Dia. (in)	Max. Trench Width (ft)			
0 to 2	8	3x8	8	4x4	8	2½	8	1½	3	None	--	
	4	2x10	4	4x4	8	2½	8	1½	3	4	4x4	
	2	2x8	2	4x4	8	2½	8	1½	3	4	4x4	
2 to 4	8	4x10	8	4x4	8	2½	6	2	6	None	--	
	4	3x10	4	4x4	11	3	10	2½	12	4	6x8	
	2	3x10	2	4x4	11	3	10	3	15	4	6x8	
4 to 6	8	4x12	8	4x4	6	2½	6	2	8	None	--	
	4	3x12	4	6x6	15	3	8	2½	12			
	2	3x8	2	4x4	8	2½	9	2	10	4	8x8	
6 to 8	8	6x8	8	6x6	15	3	10	2½	11			
	4	4x10	4	4x4	10	2½	10	2½	13	4	8x8	
	2	3x10	2	6x6	15	3	10	3	15			
8 to 10	8	6x8	8	4x4	2	2½	5	2	6	None	--	
	4	4x10	4	6x6	15	3	8	2½	10			
	2	3x10	2	4x4	4	2½	6	2	8	4	8x8	
10 to 12	8	6x10	8	6x6	15	3	10	2½	12			
	4	4x10	4	4x4	4	2½	10	2½	13	4	8x8	
	2	4x10	2	6x6	15	3	10	3	15			
12 to 15	8	6x10	8	6x6	8	2½	3	2½	8	None	--	
	4	6x8	4	8x8	15	3	6	3	12			
	2	4x10	2	6x6	10	2½	6	2½	10	4	8x10	
15 to 20	8	6x8	8	8x8	15	3	9	3	15			
	4	4x10	4	6x6	12	2½	8	2½	12	4	8x10	
	2	4x10	2	8x8	15	3½	10	3	15			

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CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD(d) Protective Shields and Welding Huts.

(1) If protective shields or welding huts are used to protect workers, they shall be constructed of steel or other material that will provide protection at least equivalent to that afforded by the materials specified in Tables 1 and 2.

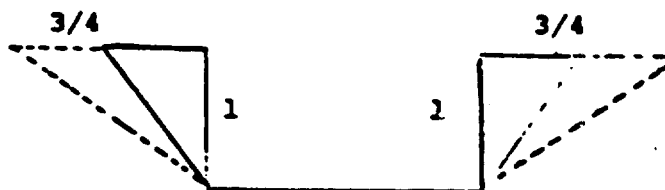
(2) Plans and calculations prepared by a civil engineer currently registered in California shall be made available for field inspection at the site where the shield or welding hut is used.

(e) Bell or Pot Holes.

(1) Bell (or pot) holes shall provide adequate clearance for the work to be done, and shall be supported by shoring and bracing as required by these Orders for trenches unless protective shields or welding huts are used.

(2) If the operation performed in the bell (or pot) hole requires that an employee use welding equipment from a reclined position on the bottom, the bell (or pot) hole excavation shall be of such shape that the employee will have adequate space for the performance of this operation without removing any of the required shoring system.

(f) Sloping or Benching Systems. In lieu of a shoring system, the sides or walls of an excavation or trench may be sloped or benched, provided equivalent protection is thus afforded. Where sloping is a substitute for shoring that would otherwise be needed, it shall be 3/4 horizontal to 1 vertical except where the instability of material requires a slope greater than 3/4 to 1.

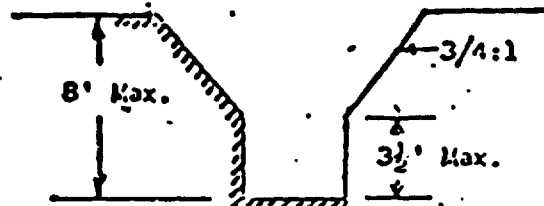


flatter than  
3/4 to 1

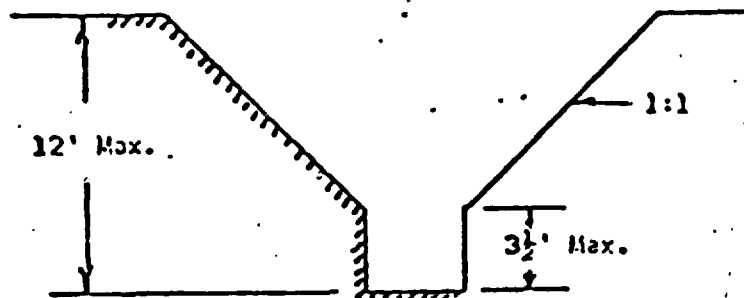
## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Exceptions:

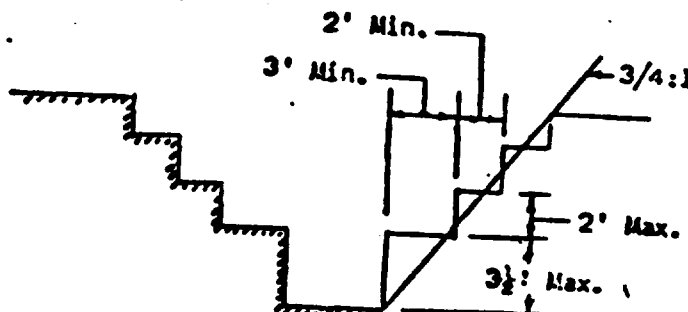
(1) In hard, compact soil where the depth of the excavation or trench is 8 feet or less, a vertical cut of 3 1/2 feet with sloping of 3/4 horizontal to 1 vertical is permitted.



(2) In hard, compact soil where the depth the excavation or trench is 12 feet or less, a vertical cut of 3 1/2 feet with sloping of 1 horizontal to 1 vertical is permitted.



(3) In hard, compact soil, benching is permitted provided that a slope ratio of 3/4 horizontal to 1 vertical, or flatter, is used.



**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Amend Section 1542 to read:

**1542. Shafts.****(a) General.**

(1) All wells or shafts over 5 feet in depth into which employees are permitted to enter shall be retained with lagging, spiling, spiling, or casing.

(2) The lagging, spiling or casing shall extend at least one foot above ground level and shall be provided the full depth of the shaft or at least five feet into solid rock if possible.

NOTE: See pertinent portions of Section 1540 for additional requirements relating to wells and shafts.

(b) Small Shafts Dry-Cemented Hard Compact Ground. Two-inch (nominal) cribbing may be used in square shafts not over 4 feet square in dry-cemented hard compact ground. Each member shall be cut 1/2 way through the width of the member and dovetailed into position so each member will act as a shore as well as lagging. Strips shall be nailed in each corner to prevent the boards from dropping down.

**(c) Shafts in Other Than Dry-Cemented Hard Compact Ground.**

(1) A system of lagging supported by braces and corner posts shall be used for square or rectangular shafts. Corner posts of 4-inch by 4-inch material are normally acceptable in shafts 4 feet square, or smaller, if they are braced in each direction with horizontal 4-inch by 4-inch members at intervals not exceeding 4 feet. Braces and corner posts in larger shafts shall be correspondingly larger.

(2) Round shafts shall be completely lagged with 2-inch material which is supported at intervals not greater than 4 feet by means of adjustable rings of metal or timber that are designed to resist the collapsing force, or cased in a manner that provides equivalent protection. Means shall be provided to hold rings and lagging in place.

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

~~(d) -- Shafts over 250 feet in depth shall have a manway partitioned off with 2-inch material or equivalent and shall have a ladderway with railed platforms every 30 feet.~~

~~(e) Belled Excavation. No workman shall be required or permitted to enter any well or shaft, particularly those drilled for foundation footings, for the purpose of enlarging the bottom by hand or similar work, unless the walls of the shaft are supported as described in these Orders, or unless a casing affording equivalent protection is in service. The belled section of any additional shaft excavation in which men work shall also have equivalent bracing if the shaft casing does not provide protection. The shaft casing or shoring is not acceptable for belled excavation protection where the height of the bell exceeds 4 feet or its horizontal dimension extends 3 feet or more beyond the shaft wall line. Additionally, men entering such shafts shall wear a body harness securely fastened to a line individually manned and separated from any line used to remove materials from the excavation.~~

~~Note: Refer to Section 1532 for requirements prior to entering confined spaces.~~

~~History: 1. Amendment of subsection (e) filed 5-21-75, effective thirtieth day thereafter (Register 75, No. 21).~~

(d) Bell Excavations. Provisions for the protection of workers that are engaged in bellling or enlarging the bottoms of shafts by hand shall include at least the following elements:

- (1) Sufficient physical protection from potential ground movement or collapse.
- (2) Adequate mechanical ventilation.
- (3) A line, suitable for instant rescue, securely fastened to a shoulder harness and worn by each employee entering the shaft(s).
- (4) A properly equipped hoist and platform for hoisting or lowering workers in shafts over 50 feet in depth.
- (5) Barriers that prevent materials from falling into the shaft(s).

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Amend Subsections (a), (d) and (e) of Section 1544 to read:

**1544. Earthwork and Excavating.**

NOTE: See pertinent portions of Section 1548 for additional requirements relating to earthwork and excavating.

(a) Whenever the Division considers that the height and condition of the face constitutes a serious hazard to employees, it shall require the installation of a bench or other suitable method of working shall be required.

(b) When a bench or multiple-bench method of operation is required, a setback of at least  $\frac{1}{2}$  the height of the single face or bank for each section of the face or bank shall be required.

(c) When determining the maximum permitted slope of the face, consideration shall be given to:

- (1) Nature of the material being excavated.
- (2) Extent to which the material is cemented or consolidated.
- (3) Height of the face.
- (4) Type and size of equipment used at the face and amount of protection this equipment affords the operator.
- (5) Safety of employees who are not protected by such equipment.

(d) Where the face is composed of loose or unstable materials, the slope of the face shall not exceed  $\frac{3}{4}$  horizontal to 1 vertical where the height is greater than that which can be reached by the dipper or bucket of the excavator or loader being used.

(e) Where the face is composed of moderately compacted materials that are not firmly cemented or consolidated but which experience indicates will stand well in place, the slope shall not exceed  $\frac{1}{2}$  horizontal to 1 vertical where the height is greater than can be reached by the dipper or bucket of the excavator or loader being used.

Amend Subsection (a) of Section 1545 to read:

**1545. Overburden.**

(a) No person shall be permitted under a face or bank where stripping or other similar operations constitute a hazard.

**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Amend Subsections (a), (d) and (e) of Section 1546 to read:

**1546. Face Inspection and Control.**

(a) A daily physical inspection shall be made of faces and banks, including the tops, where men employees are exposed to falling or rolling materials. The inspection shall be made by a competent-man qualified person who shall dislodge or make safe any material dangerous to employees, or shall cause such material to be dislodged or made safe.

(b) No person shall be permitted to work near a face made unsafe by primary blasting, rains, freezing or thawing weather, or earthquakes until the face has been inspected and made safe.

(c) Overhanging banks are forbidden, except:

(1) Where material is moved away from the face by mechanical equipment having controls located at a safe distance so that no employee is required to approach the face in the course of normal operation.

(2) Where the bank is undercut with a stream of water and the monitor is located at a safe distance from the bank.

(d) Where necessary, a-competent-trained an employee shall be employed at the face and instructed to give warning when loose rock or other materials are about to fall.

(1) The employee shall be provided with a whistle, siren, or other devices that will give adequate warning to employees.

(2) The employee shall have no other work to distract his attention from his duties as defined above.

(e) When working at night, sufficient illumination shall be provided throughout the working area so that movement of men employees and equipment can be readily observed.



**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Amend Section 1547 to read:

**1547. Protection of Workers at the Face.**

(a) No work shall be permitted above or below men employees at the face if such work endangers their safety.

(b) Workers at the face shall be protected as follows:

(1) On top of the bank, by fencing with guardrails or ropes; by using railed platform; or by using safety belts and life lines. This does not apply where the bank is less than 20 feet high or the slope below is less than 3/4 horizontal to 1 vertical or where no work is performed within 10 feet of the edge.

(2) On the face, by removing loose rock from over the working place and by the use of safety belts and life lines, portable staging, boatswain's chair or skips especially designed for use at faces. If a boatswain's chair is used, the employee shall be attached thereto with a safety belt and life line equipped with an approved effective descent control device.

~~When-necessary-for-safety,~~ 2 Two or more persons shall be employed in cooperation with each other in drilling, blasting, or removing loose rock.

Life lines used for scaling or inspection shall be protected from excessive fraying or damage or and shall have a wire center rope.

(3) At the foot of the bank by removing loose rock from above the working place, and maintaining a ready way of exit to a place of safety.

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Amend Appendix Plate C-22 to read:

PLATE C-22  
BEARING VALUE OF SOIL

Shores and similar members that depend upon earth for support will probably require foot blocks or sills to distribute the load. In the absence of test data that establish the sustaining power of the soils in question, the following information should be helpful in determining the size of ~~the~~ sill needed to assure adequate support from the soil

Soil type	Tons allowable per square foot
Soft clay -----	1
Wet clay -----	2
Sand and clay, mixed in layers -----	2
Fine dry sand -----	3
Hard dry clay -----	4
Coarse compact dry sand -----	4

DESIGN CONSIDERATIONS  
EXCAVATIONS, SLOPES AND BENCHES

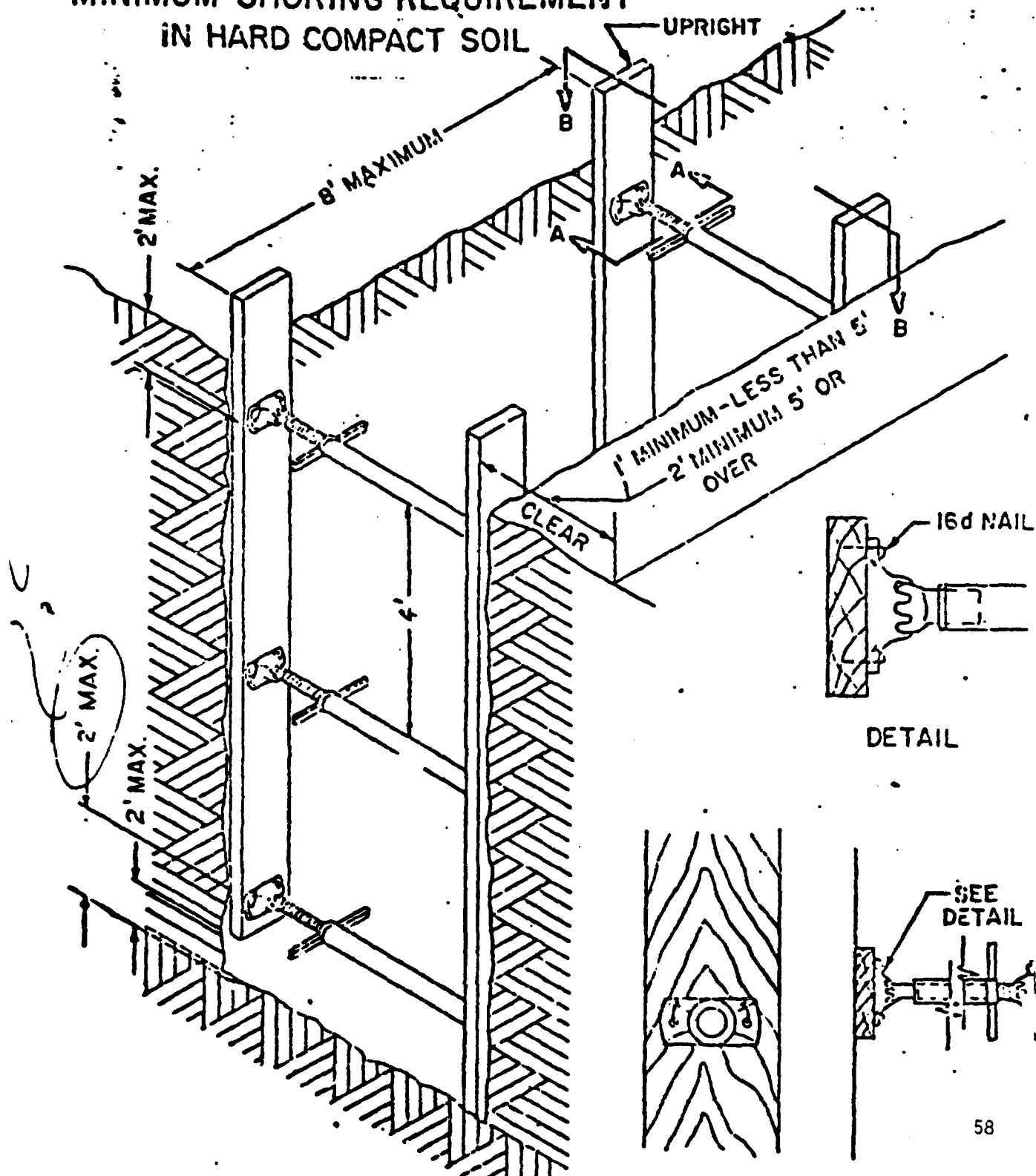
The determination of the slope or bench configuration or design of the shoring system shall be based upon careful evaluation of such pertinent factors as the following:

- (1) Depth and width of cut.
- (2) Possible variation in water content of the material while the excavation is open.
- (3) Anticipated changes in materials from exposure to air, sun, water or freezing temperatures.
- (4) Loading imposed by structures, equipment, overlaying material or stored material.
- (5) Vibration from equipment, blasting, traffic, trains or other sources.
- (6) Existing underground facilities.
- (7) New or old adjacent excavations.
- (8) A minimum coefficient of active earth pressure of 35 pcf ( $K_a=35$ ) shall be used in all calculations unless a soils evaluation indicates otherwise.

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Adopt new Appendix Plate C-24-a to read:

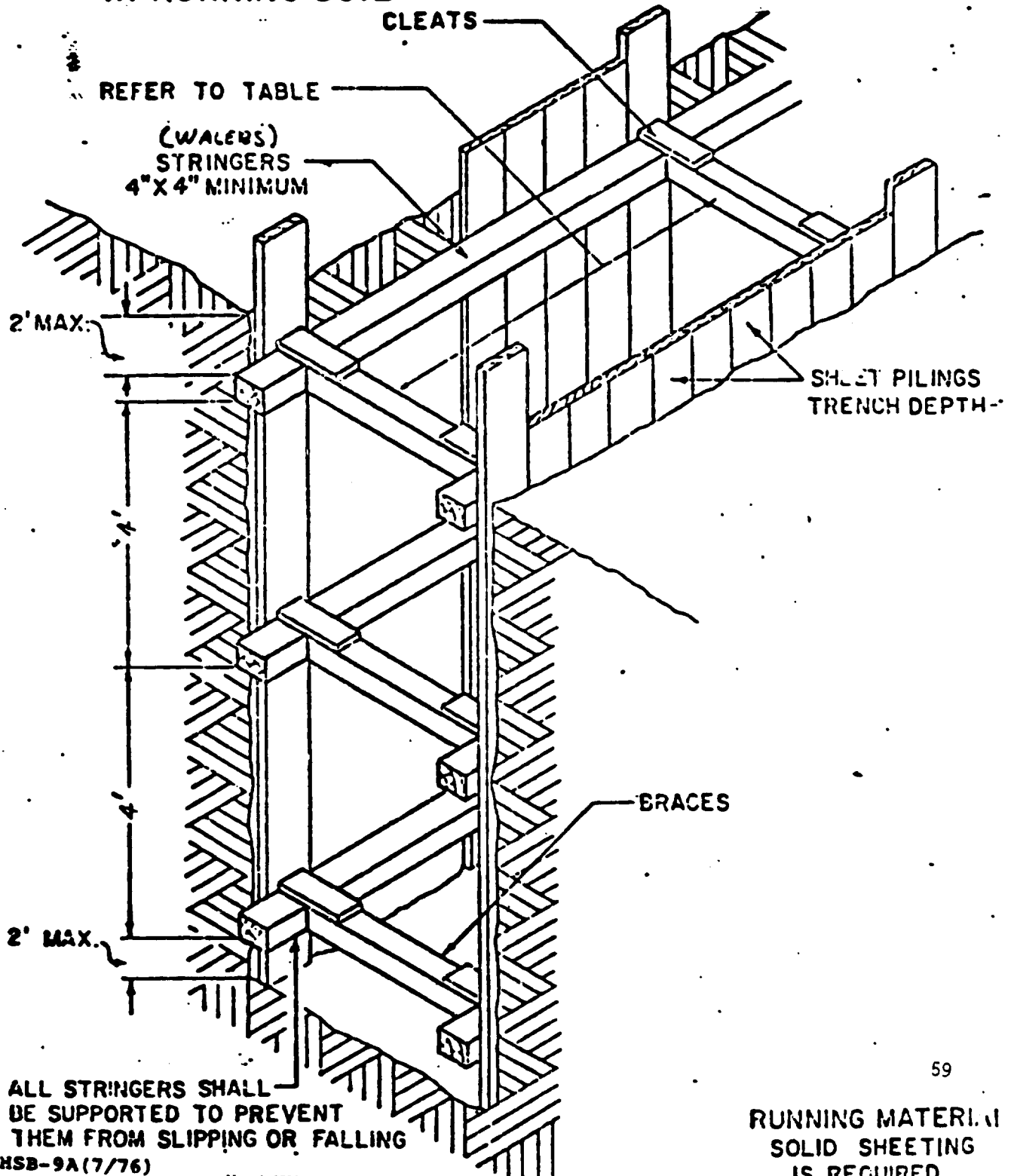
Plate C-24-a

MINIMUM SHORING REQUIREMENT  
IN HARD COMPACT SOIL

# CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Adopt new Appendix Plate C-24-b to read:  
~~Plate C-24-b~~

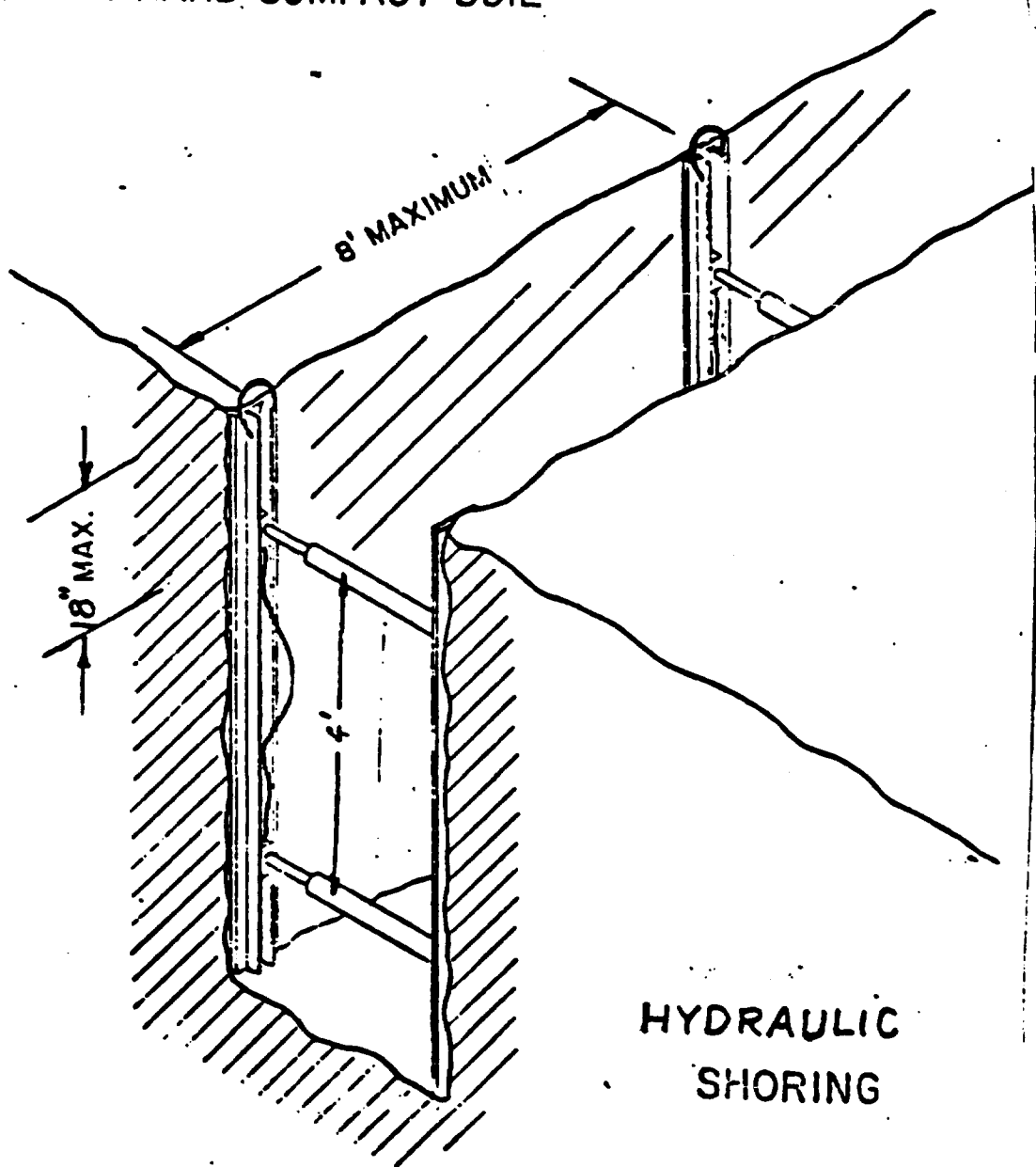
## CLOSE SHEETING METHOD IN RUNNING SOIL



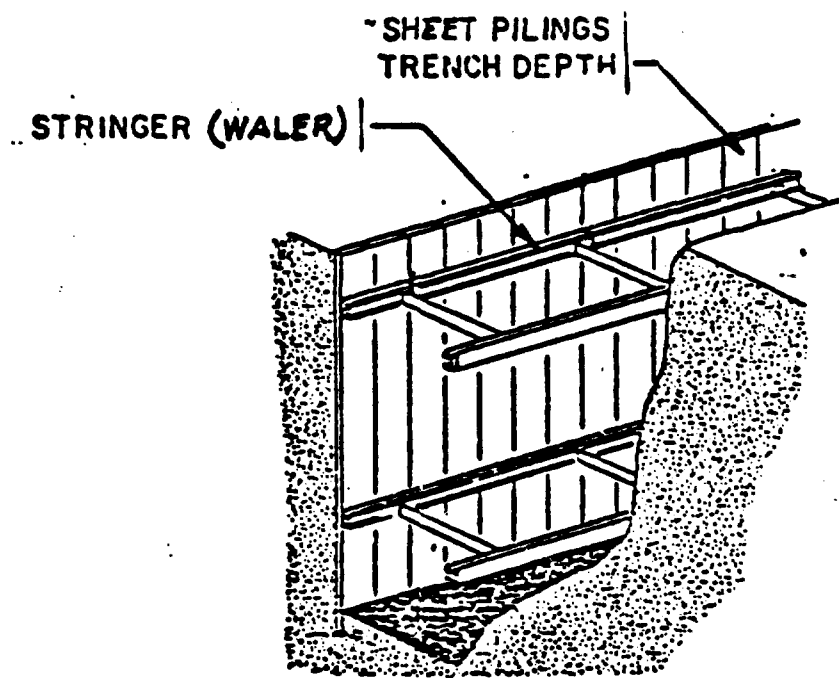
STANDARDS PRESENTATION  
CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Pg 34-A OF 34

Adopt new Appendix Plate C-24-c to read:  
Plate C-24-c  
MINIMUM SHORING REQUIREMENT  
IN HARD COMPACT SOIL



Adopt new Appendix Plate C-24-d to read:  
**CLOSE SHEETING METHOD**  
**1. IN RUNNING SOIL**



**HYDRAULIC  
SHORING**

**RUNNING MATERIAL  
SOLID SHEETING  
IS REQUIRED**



UNITED STATES DEPARTMENT OF COMMERCE  
National Bureau of Standards  
Washington, D.C. 20234  
Bldg. 226, Room B162  
(301) 921-2648

July 24, 1981

Mr. Clifford Simmons  
Mr. Arthur Schmuhl  
Mr. James Lapping  
Mr. John Ramage  
Mr. Paul Bouley  
Mr. Ronald Stanevich  
Prof. Jack Mickle  
Mr. John Pannullo

Gentlemen:

Enclosed is a copy of my draft memorandum on the Boston Workshop. Please send me your comments before August 14. I shall revise the memo after I receive your comments. In particular, I want to make sure that I have no inaccuracies and that I didn't fail to address important issues which were raised.

Sincerely,

Felix Y. Yokel, Leader  
Geotechnical Engineering Group  
Structures and Materials Division  
Center for Building Technology, NEL

Enclosure

cc: Mr. John Chambliss  
Mr. Edward Hayden  
Mr. William Driskill  
Mr. Paul Henson  
Mr. Bill Zoino  
Mr. Richard Critchell  
Mr. Robert Briant  
Mr. Clayton Morin  
Mr. C. Joseph Williams



UNITED STATES DEPARTMENT OF COMMERCE  
National Bureau of Standards  
Washington, D.C. 20234  
Building 226, Room B162  
(301) 921-2648

July 24, 1981

MEMORANDUM FOR Records of the NIOSH Excavation Project

From: Felix Y. Yokel

Subject: Workshop in Boston, Massachusetts, July 14, 1981

This memorandum is to record my overall impression and my reaction to important questions that were raised in the Workshop. I expect that a Workshop report will be prepared by the Organizing Committee on the basis of taped records and written depositions.

(1) General: This was the last in a series of five Workshops and many issues that were raised were discussed in previous Workshops and will therefore not be discussed herein in much detail. My general impression was that the AGC group participating in this Workshop did not formulate strong opinions on specific issues like those expressed in some of the previous Workshops (Wisconsin - local options; Atlanta and Dallas - strong emphasis on the issue of "qualified person," the 24-ft. depth limit and an increased allowable slope for Type A soils; San Francisco - adoption of some concepts from the proposed California Standard). This is perhaps an indication of a greater diversity in work practice in the New England and Mid-Atlantic regions. Members of the New Jersey NUCA were generally supportive of the recommendation. Representatives of trench box manufacturers submitted a position statement (see Attachment 1) which did not substantially differ from that submitted in Dallas (which is discussed in the Dallas memorandum). Other trench box manufacturers, which communicated with me prior to the Boston Workshop do not agree with this statement and are supportive of our recommendations. A letter discussing the trench box manufacturers statement in the Dallas Workshop is attached (Attachment 2). Representatives of the Eastman Kodak Company came in with prepared recommendations, which are generally supportive of the proposed revisions of Subpart P but also make numerous specific recommendations. To some extent, the Kodak submission is a new viewpoint since it reflects the needs of an owner/contractor organization which is primarily engaged in the repair of utility damage as distinct from utility construction in which most of the AGC and NUCA contractors are engaged (Attachment 3). AFL-CIO in essence reiterated statements made in previous Workshops. In the opening statement, the AFL-CIO representative stated that Contractors and Unions should make joint recommendations. The substance of the AFL-CIO position was summarized in the following statement: Excavation safety could be accomplished in several ways:



1. by Hamurabi's Coda,
2. by OSHA enforcement,
3. by an Engineer, and/or
4. by a Standard Practice.

AFL-CIO would like to see that the workers in 95% of all excavations be protected by a standard practice, and in the remaining 5% by an engineer.

The ASFE representative noted that ASFE is working on a summary recommendation which will reflect their position on various issues. ASFE also noted that comments should be consolidated by an industry-wide committee in a unified summary. ASFE stressed that local practices should be recognized and should supplement the national provisions. This concept goes somewhat beyond my recommendations for local options which I conveyed in the Wisconsin and California memos, and perhaps reflects a better long-term approach, however the implementation of this concept requires additional work.

I particularly welcome the concept of a joint industry recommendation advanced by AFL-CIO and ASFE. I strongly recommend to go beyond that and develop consensus industry standards. It is my judgement, on the basis of the five regional Workshops, that such a standard can be successfully developed and adopted in a relatively short time. Federal regulations which are backed by such a standard could probably be less sweeping, more effective, and less difficult to enforce.

(2) Soil Classification: Two issues were raised in conjunction with the proposed soil classification:

1. It was suggested that we go back to the matrix classification (Attachment 4).
2. It was stated that the footnotes are too complex.

In conjunction with #1, I have no doubt that in terms of categorizing soils for stability and lateral pressure, the matrix classification is the best solution. It would permit us to distinguish between sands and medium clays in Type B soils and between submerged sands and soft clays in the Type C soils. This would result in enhanced safety and economy. The problem with the matrix is that you cannot memorize the 16 matrix intercepts, except if you have a photographic memory. Thus you would have to use some visual aid on the job, such as a printed table, or a table engraved on some metal plaque. I personally do not believe that you can get foremen to use a chart routinely. It is bad enough that we will have to do this for surcharge effects. I would, however, strongly recommend that 1) we use the matrix as an educational tool, and 2) we perhaps try to use it in the field on an experimental basis.

In conjunction with #2, the footnotes to Table 1 play an important role. I will give an example: there is no way a geotechnical engineer could ever determine for sure whether you have a "compacted sharp sand" as shown in Table P-1 of the present OSHA regulations. Thus you can never resolve a

dispute. The footnote in Table A on the other hand will tell you exactly what soils fall into Class A, B or C. The footnotes also convey other important information such as the thumb test. I doubt very much they can be simplified without creating ambiguities.

(3) Excavation Below Bottom of Sheeting: Three points were made:

- 1) It was suggested to change the wording of 1926.652(5)(iii) to read "Short-term excavation up to \_\_\_\_\_ ft. below . . ." Sometimes an excavation may be long-term, but the sheeting is undercut for a short time to install a pipe.
- 2) It was suggested to limit the length of permitted undercutting.
- 3) It was noted that in California undercutting is rounded, so that the depth below sheeting on the side of a trench is less than in the middle.

(4) Position of Upper Strut Below Top of Trench: It was stated by a shoring industry representative that it is common practice to place the upper strut 2 ft. below the top of the trench. New Jersey NUCA stated that in their area the distance tends to be 3 ft. There is no stipulation in our proposal, but perhaps there should be one tied to sheeting thickness.

(5) Guidelines: Trench box manufacturers noted that the guidelines are referenced in the proposed Subpart P revision and should therefore be subject to public comment. An OSHA representative noted that no guidelines would be referenced in the regulations.

(6) Page 5, Section 1926.650(i): It was noted that the statement would force a truck driver to leave the truck while it is loaded and is thus too restrictive. It should perhaps state "No unprotected person . . ." AFL-CIO noted that it should state "no persons shall be permitted under loads" - regardless how the loads are handled. It was also proposed to strike the last sentence in (i).

(7) Page 5, Section 1926.650(h): "Approved respiratory protection" should not be listed as the only means of protection.

(8) Page 6, Section 1926.650(j): In spite of the California recommendation, Workshop participants favored keeping "competent person."

(9) Page 6, Section 1926.651(a): Some participants felt the statement is not very clear. The California version (see San Francisco memo) which I read to the participants was favored.

(10) Page 7, Section 1926.651(e): A representative from the Operating Engineers noted that this section should list equipment that is used in excavation work and no other equipment. It was also noted that equipment positioned on top of the slope at the end of the excavation should be excluded - only equipment placed next to the sides of finished excavations. It was also noted that the word "near" is much too vague and that this Section may be redundant.

(11) Page 7, Section 1926.651(g): It was again recommended to eliminate this section. It was noted that the "stoplog" only adds hazards.

(12) Page 7, Section 1926.651(k): The need for this section was questioned (note comments in San Francisco memo).

(13) Page 7, Section 1926.651(i) and (j): It was proposed to eliminate these sections.

(14) Page 8, Section 1926.651(m), (r), (t): It was proposed to eliminate these sections. (m) is self evident, (r) and (t) are meaningless.

(15) Page 8, Section 1926.651(o): It was noted that protection in a belled hole is too complicated an issue to be handled as an excavation.

(16) Page 8, Section 1926.651(p): It was suggested that one means of exit is enough for small excavations.

(17) Page 8, Section 1926.651(s): It was proposed to eliminate the first sentence. Trench box representatives propose to use "equivalent protection." This is tied to their objection to our pressure diagrams.

(18) Competent Person: It was proposed that competent persons should be trained - superintendents licensed, foremen trained.

(19) Page 9, Figure 1: It was noted that while the 1 to 1 slope in the figure reflects accepted engineering practice, a footnote should be added noting that distance from footing should be increased if water seeps into the side of the excavation.

(20) Page 9: It was noted that both the "competent" and the "qualified" person should be designated by the employer.

(21) Page 10, (a)(3): St. Louis AGC proposed that the depth limit below which an engineer must be involved should not be applied to sloped excavations.

(22) Page 10, (b)(1): It was suggested that in the Northeast, short-term excavations could be 3 or even 7 days, and perhaps more. Parameters identified were desiccation for sands, fissuring and creep for clays, sensitive clays, and effects of water.

Again opinions were expressed to drop the distinction, but it was recognized that we would have to become more conservative.

(23) Page 10, (b)(4)(i): Trench box people suggested that this section is confusing. It was however noted by ASFE the alternative of having to use an engineer may be even less attractive. I believe that the use of the "adjusted depth" is a necessary evil.

(24) Page 13, (ii), last paragraph: Shoring systems, trench shields and trench boxes . . . The allowable 33 percent strength increase was questioned.

(25) The "Operating Engineers" representative noted that he feels that there is a tendency for those who should assume responsibility for the safety of the men to avoid it. I believe that this feeling by AFL-CIO underlies their position in the dispute surrounding the "qualified person" concept. Perhaps the dispute can be resolved by looking at this problem.

(26) New Mexico AGC noted that great difficulties arise from the fact that bid documents prepared by municipalities and government agencies do not recognize the excavation safety problem (i.e. excavation quantities paid on the basis of 1/4 to 1 slope, etc.)

Attachments (4)

Boston July 14, 1981

STATEMENT OF POSITION AND RECOMMENDATIONS  
ON  
REVISION TO SUBPART P  
OF THE  
SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION  
PRESENTED BY  
THE MAJOR MANUFACTURERS OF TRENCH BOXES  
AND TRENCH SHIELDS OF THE UNITED STATES

John B. Cook  
Efficiency Production, Inc.

Wendell Wood  
Griswold Machine & Engineering

## GENERAL STATEMENT OF POSITION

A review in detail has been made of the proposed revisions in Subpart P 1926.650 - .651 - .652 - .653.

This review was made by, and on behalf of, the major trench box manufacturers of the United States, and represents their consensus opinion of the changes in the proposed standards.

It is our position that the intent to clarify and simplify, as it relates to the revised changes of Subpart P, has failed, and in fact, has made it more confusing and more difficult to apply in the field. The proposed design criteria as they relate to trench boxes do not conform to accepted engineering practices. We have specific recommendations for changes in the proposed revisions.

It is also our position - that if the Guidelines are going to be referenced within Subpart P and therefore become effectively a part of the law - they should be discussed publicly as a part of the workshop and in public hearings.

1926.650 GENERAL PROTECTION REQUIREMENTS - NO COMMENT

1926.651 SPECIFIC EXCAVATION REQUIREMENTS

PAGE

- 8 - item (s)            Should read ... Portable trench boxes or sliding trench shields may be used for the protection of personnel. Where such trench boxes or trench shields are used they shall be designed, constructed and maintained in a manner which will provide equivalent protection to that provided by the shoring required for the excavation as defined by accepted engineering practice.

1926.652 SPECIFIC SHORING, SLOPING AND SHIELDING REQUIREMENTS

PAGE

- 9 - item 2a            Should read ... Qualified Engineer
- 10 - item (b) (1)      Should be no arbitrary distinction between long-term and short-term excavation.
- 10 - item (4) (i)      We recommend that this section be clarified and simplified for effective field application.
- 13 - item (ii) a        Should read ... lateral pressure at the bottom of excavation equal to the equivalent weight effect ( $W_e$ ) in Table 1 times the depth of cut with lateral pressure diagram appropriate to the construction as determined by an engineer.
- We object to the footnotes attached to Table 1 as being too technical and overly complicated for interpretation by field personnel, and recommend they be simplified.
- 13 - item (ii) c        The last paragraph of this section should read ... shoring systems shall be designed in accordance with accepted engineering practices.

PAGE

(This statement excludes the 33% increase in allowable working stresses or an equivalent strength reduction.)

13 - item (iii)  
Paragraph 2

Should read ... Shoring systems and trench shields shall be selected in the field on the basis of accepted engineering practice.

13 - item (iii) (a) Trench shields, trench boxes, and pre-fabricated strutwale assemblies and other pre-fabricated assemblies shall be rated for the maximum depths in all types of soils in which they can be selected and used accordingly from charts prepared by the manufacturer.

16 - item (4)(iii)(c) Should read ... rated by an engineer ... .

16 - item (5)(iii) Should read ... Excavation up to 3 feet below the bottom of sheeting, trench boxes, or trench shields is permitted provided that: ... (and we agree with items a & b.)

1926.653 DEFINITIONS APPLICABLE TO THIS SUBPART

PAGE

18 a

Should read ... Accepted engineering practices, those requirements or practices which are compatible with standards required by a registered professional engineer.

Question - why are you making reference to the guidelines when they are not meant to be a part of the law?

19 m

Should be eliminated.

19 o

Should read ... Negotiable slope is a slope on which a person can egress from or ingress to an excavation with relative ease and speed to assure reasonable safety.



PAGE

19 t                      Should be eliminated.

19 z                      Should read ... See Figure 4 (Correction)

GUIDELINES SUPPLEMENTING SUBPART P

If the Guidelines are going to be referenced within Subpart P, do they not become effectively a part of the law? If so, they should be discussed publicly as a part of the workshop and in public hearings.

ANSWERS TO DR. YOKEL'S QUESTIONS

- #1 No comment.
- #2 No comment.
- #3 No comment on 24 foot limitation.  
On question of should qualified person be substituted for engineer ... "No, as it relates to this specific question."
- #4 No distinction should be made between short-or long-term excavation.
- #5 No comment.
- #6 No comment.
- #7 Yes, and should be conveyed as part of the definitions.
- #8 No comment.
- #9 Yes.
- #10 Yes.
- #11 No comment.
- #12 No.
- #13 No - Statement should not be deleted.

While this is true, I feel that the participants in these Workshops have the knowledge and experience to address all the issues involved and will do so successfully.

(2) Opposition to Change in Existing Provisions: Opposition to a change in the present version of Subpart P was expressed by an Illinois contractor who works primarily on highway projects. This time I gained some insight into the rationale for this position. I noted in my Wisconsin memo that people who tend to agree with our recommendation are less likely to express their opinion in the Workshop than those who oppose certain recommendations. The same thing happened to some extent when we conducted our field study. Almost all the contractors that responded were dissatisfied with Subpart P. However, the responding contractors who now have concern about changes in the existing regulations are more involved in earthwork, wide excavations, borrow pits, etc., where conflicts with OSHA do not normally arise. They are concerned with two issues.

- a. The present provisions have been interpreted in the courts in past litigations. These interpretations by court rulings tell the contractor precisely what he can do. When we now propose to change the wording of many provisions, there will again be uncertainty about their interpretation by the courts, and we will lose the benefit of experience gained in past conflicts.
- b. We merged "trenches" and "excavations". There is now concern that as a result new restrictions will be imposed on excavation work. Part of this problem can probably be resolved by a clear definition of "exposure." However we need to carefully review our new recommendations to make sure that they do not inadvertently result in unnecessary restrictions on excavation work. An example of this, which was noted in the Workshop, would be the application of Section 1926.651(d) to borrow pits.

(3) Use of OSHA Regulations on Federal Projects: It was noted that other Federal Agencies are not bound by OSHA regulations and use their own procedures. This situation can lead to specifications which are difficult to implement while using methods which comply with our recommendations. I am not sure what can be done about that, but the situation could be brought to the attention of the Administration at an appropriately high level by the participating organizations of the Workshops.

(4) Trench Boxes: Trench box manufacturers suggested that the lateral-load requirements for trench boxes should be different from those for shoring. This is based on the contention that a trench box can deflect considerably and in general will not restrain lateral soil movement as much as a shoring system, thus causing the pressure distribution to resemble that acting on a retaining wall. This would make the square pressure diagrams associated with the Standard Practice too conservative. At this time I cannot evaluate the technical merits of this claim in detail, but I have several preliminary thoughts:

- a. In addition to the allowable stress increases for short-term excavation, we also allow a 20 percent load reduction for wales and a 33 percent reduction for sheeting. These reductions, which account for arching effects would apply to the horizontal framing members and the skin of a trench box. I wonder if the industry considers taking advantage of these reductions in their analysis.
- b. The trench boxes I saw had about equal stiffness (in terms of lateral displacement characteristics) near the top and bottom. Thus, I cannot see how a trench box could act like a retaining wall, namely rotate inward while the base is fixed.
- c. It is obvious that a trench box permits greater lateral inward displacements of the excavation wall than a shoring system. In granular soils this will result in a reduction in lateral soil pressures. In clays, however, the situation is more complex. Overconsolidated clays such as those in Austin, Texas where we conducted pressure measurements (NBS GCR 80-202) will develop tension cracks upon lateral expansion, resulting in increased lateral soil pressures. It should be noted that Type B soils include clays.
- d. The greatest problem that would arise if stiffness characteristics of shoring systems are considered is complexity (which our recommendations are designed to avoid). Each case would have to be considered on its own merit. Considering the inadequacies and complexities of present models for soil/structure systems and our general lack of data on lateral pressures in shallow braced excavations, it may be difficult to make a convincing case, and detailed analysis would not be much better than an educated guess.
- e. While the proposed square pressure diagrams may be on the conservative side, the 40 lb/ft.<sup>3</sup> equivalent weight effect is not conservative for medium clays which fall under Type B soils and are the most common soil type.

It may be helpful if ASFE could review this problem. I am very much afraid that we may be creating an albatross as soon as we deviate from the principle of simplicity in the standard practice.

(5) Configuration of Excavations with Compound Slope: Two problems were discussed in conjunction with Figure 2, page 12:

- a. It was suggested to remove the sharp corners in the drawn cross-sections, since these cannot be dug in the field with ordinary equipment. I suggest that we draw broken lines for the idealized cross-section and back these up with solid lines showing more rounded corners.
- b. The bank adjacent to the work area was discussed. In the previous two Workshops there seemed to be a consensus that the height of the bank should be increased to 4 ft. In this Workshop it was suggested to permit a 5 ft. bank for large pipes. In the latter case, worker protection would be derived from the large diameter pipes. I have some problems with the suggestion:

1880



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July 13, 1981

Comments by Kodak Park Division of Eastman  
Kodak Company at Boston, MA, Workshop,  
Trenching & Excavation Standards, on Working  
Draft prepared by National Bureau of Standards  
dated February 20, 1981.

The Kodak Park Division of Eastman Kodak Company does a large portion of the construction and maintenance of its buildings and underground utility lines. This includes excavations for buildings and other major structures as well as trenching for new water, sewer, and electric services. It also includes excavation for emergency repair of these underground services. We are also involved with many trenching and excavation contractors at all of our locations in the U.S. and expect that the execution of this work be done safely and efficiently.

The hazards of inadequately shored or braced excavations are well recognized by experienced persons active in that type of construction. Unfortunately, satisfactory source standards were not available when OSHA promulgated the existing 1926 standards and their subsequent enforcement efforts have not been entirely productive in the reduction of serious accidents or in providing assistance in needed safety precautions.

We believe ~~that the~~ National Bureau of Standards has done a commendable job in drafting these suggested revisions. They have recognized that excavation site conditions are widely variable and the application of judgment for each location by knowledgeable people is needed. The proposed standard is written in performance language and the supplemental non-mandatory guidelines that are included should be very helpful in the solution of specific problems. Eastman Kodak supported a similar approach used by OSHA in the revision of the General Industry Standards for Fire Protection which were adopted last December, and the Electrical Workplace Standards which were adopted in April 1981.

Attached are our comments on the identified issues plus some addition items. We will be pleased to elaborate on these comments if additional information would be helpful.

Some Issues that Should be Considered in the Workshop

1. Page 6. Section 1926.651(a): This section appears to fall within the scope of Subpart S. Should it be dropped?

A. Subpart S, Tunnels and Shafts, Caissons, Cofferdams, and Compressed Air is not the appropriate place to call for locations of utilities prior to excavation. The problem of interrupting utilities and the resulting employee hazards are most likely to be found while preparing surface excavations and thus belongs in Subpart P.

2. Page 8. Section 1926.651(p): Should the exit requirements for excavations start at 5 ft rather than 4 ft depth?

Please refer to our general comments on this section.

A. Yes, it is reasonable to expect the type of individuals who work in excavations to have the strength and agility to make his own way out of a 5 ft deep excavation without the aid of something or someone else. Also, the additional one-foot allowance will include many trenches, and a pipe is often present which would serve as a step to aid the exit process. Also, in trenches, the work is being done in a constantly changing location and the need to frequently move the ladder or exit device may be considered a nuisance by the trench workers if they do not believe it is practical to use.

Should exit requirements be waived for excavations which are wide enough to permit people to escape toward the center of the excavation?

A. Yes, the major concern for death or injury is in the relatively narrow excavations such as trenches where escape during rapid cave-in is very much more difficult because escape options are far fewer than in wider excavations. The alternative requirement should be that the excavated area allow unimpeded movement away from the excavation walls to a safe location.

... we believe this is desirable. ... it may be helpful to add a sentence to the excavation definition...

Should it be recognized that large enough pipes or other covered structures can shelter people?

The intent of this question is not clear. A large pipe being installed can serve as a temporary refuge, but it does not seem appropriate to include that as part of a planned protection system in lieu of shields or shoring. However, a permissible practice would be to permit the use of the pipe as a shelter while the trench shield is being relocated which is a normal procedure in many situations. Alternatively, existing large pipes or structures adjacent to the excavated area can serve as a type of shoring to help support the excavation side. Good judgment and sometimes engineering analysis may be required, however, for the use of pipes that appear to give marginal support.

Should "negotiable slope" be better defined?

A. This definition seems adequate for its purpose, though there may be some arguments about a person's ability to climb a slope being used. Perhaps the only validation required should be a physical demonstration of an employee using the slope to egress or ingress before work begins.

3. Page 9. Section 1926.652(a)(2)

a) Could the depth limitation in the "Standard Practice" be extended to 24 ft?

Whether the excavation is 20 ft or 24 ft before requiring the services of a registered engineer is somewhat arbitrary. There should be some limit, however, and since the 20 ft limit has been used in several standards, such as the New York State Code Rule 23, it probably should be kept.

b) Should a "qualified person" be substituted for an "engineer"?

There are probably relatively few registered engineers who would be competent in the design of earth shoring systems or slopes, and there are probably many capable people who are not registered professional engineers who have developed suitable expert qualifications in this area. The definition of "qualified person" probably is more descriptive than the definition for "engineer" in determining a person competent in designing shoring systems and earth slopes.

4. Page 10. Section 1926.652(b)(1): Should the short-term excavation definition extend to 7-days rather than 1-day? If so, do we need more conservative requirements?

We do know that a 7-day definition for short-term excavation can be applied to most soil conditions in our area. The more commonly found soils which may range in grain sizes from clays to gravels would most likely permit a 7-day short-term definition in other parts of the country as well.

There are basically two conditions which normally change the strength of insitu soil with time after an excavation has been made, both having to do with changes in water content:

1. If an excavation is dug below the water table surface, or if an excavation is partially filled with water and this water is rapidly drawn down by pumping, relatively large pore water pressures between the soil particles remain. This may cause a temporary stability problem which will improve with time as excess pore pressures dissipate. So, when excavating primarily fine grain or relatively impermeable soils such as clays and silts, the initial water condition is important. When the walls stabilize after the water is pumped out, short-term excavation criteria can be safely applied, as long as the excavation is not allowed to refill with water. Paragraph 1926.651(d) and note 3(b) of table 1 of the draft Subpart P revision recognize this problem.
2. When excavating in granular or permeable soils such as sands, there will be a temporary apparent cohesion caused by negative pore pressures in the partially saturated, draining soils. This negative pore pressure is caused by capillary tension. As the soil in the excavation walls dries, the negative pore pressures will dissipate making the soil weaker in shear and possible causing sloughing or slides. This is a condition which will deteriorate with time and the length of time will depend on how fast the soil in the excavation walls will dry to a significant depth. Probably in normal conditions, instability will occur considerably later than 7 days after the excavation work, particularly when the excavation wall is covered with sheeting, retarding evaporation of water.



We feel the large majority of the cases will allow the extension of short-term to 7 days. Perhaps an extension to 3 days might be a good compromise which would allow, as a worst case, excavation before a weekend to backfilling after a weekend, as long as water is not allowed to accumulate in the excavation and be pumped down again.

5. Page 11. Table 1: Should the stipulation of maximum slope be limited to 3/4:1? Should the suggested performance requirement (footnote b)(the "stable slope" concept) be used? Will this approach work?

A. The 3/4:1 maximum slope should be reasonable.

Judgments of the description of the soil encountered, degree of saturation and changing conditions as the excavation progresses might overlook something, possibly resulting in a marginal stability problem from time to time. There should be some means to correct such shortcomings if there is evidence of instability, and the provision to flatten the slope by 1/4:1 should be appropriate. This adjustment should be made before anyone enters the excavation.

6. Page 12. Figure 2: Should the allowable bank next to the work area in Cases II, III, and IV be increased to 4 ft? Should "Case IV" be limited to excavation by trenching machines?

A. The purpose, usually, for having a sub trench at the bottom of a sloped excavation is to provide a better lateral restraint for the pipe after the pipe is bedded and in place. This, in most cases, allows the pipe to withstand greater overburden and ground surface loads without failure. For large pipes (6 ft or more in diameter), it may be important to be allowed a deeper sub trench. For employee safety purposes, whether 3 or 4 ft is used is arbitrary, and would probably depend on judgment of the increased risk, if there is any, by going to the 4 ft sub trench. The potential volume of sliding soil, indicated by the spaces between the solid and dotted lines in figure one, does seem to be relatively small even at 4 ft. The upper portion of the trench would have to be widened or flattened to accommodate the 4 ft sub trench in order to meet the table 2 criteria. Finally, at 4 ft, the head and shoulders of most workers would be outside of the sub trench. It seems reasonable to us to extend the sub trench depth to 4 ft.

7. Page 13. Section 1926.652(b)(4)(ii): This section, unlike most others in Subpart P, is not addressed to the man in the field but to those who pre-design shoring systems. Yet the section is necessary to avoid unreasonable vagueness. Should this section be at the end of Subpart P? Should part of it be conveyed as definitions?

A. These loadings are already in the, "Guidelines Supplementing Subpart P, Section 2.2.2, 'Operational Loads'." If these loadings, with the possible exception of the impact load, are meant to also apply to job designed shoring, which Subpart P does not say, then these provisions should remain in the body of this Subpart where they are.

8. Page 16. Section 1926.652(b)(5)(ii): This section makes it difficult to implement some of the slope configurations allowed in figure 2. Should the proposed performance statements be substituted to give more options, or alternatively, should more options be specified or the specified options identified as examples of implementing the performance statement?

A. The performance statement, (Workers in excavations must be protected against rolling or sliding objects.) is really all that is needed here. Suggestions as to how this may be accomplished may be placed in the appendix if beneficial.

No mention of the amount of slope required before provisions are applied should be made. It depends on the specific situation.

9. Page 16. Section 1926.652(b)(5)(iii): Should the allowable excavation below the bottom of shoring or shields be increased to 3 ft?

A. It certainly would be useful, in some cases, to be able to extend short-term excavations to 3 ft below the shoring. It is useful to aid in the bedding of pipe. Also, more importantly to us, it better allows working around underground obstructions with shoring, particularly when reexcavating to repair a broken watermain, sewer, or similar items in a congested area. We feel it is reasonable to allow this extension if adequate attention is paid to possible unstable conditions below the shoring.

We also believe this section should be reworded to clarify that the short-term excavation requirement applies to the work below the bottom of the sheeting or shoring system. An excavation for a building or large structure would come under the long-term definition. It is often necessary to make short-term excavations within this excavation for drain lines, footings, etc. The present wording could be interpreted as prohibiting this practice. We suggest that this section be revised to read:

"A short-term excavation up to 3 ft below the bottom of sheeting, trench shields, or trench boxes is permitted provided that:."

10. Page 18. Definition of accepted engineering requirements. Should a "registered architect" be omitted since architects do not deal with excavations?  
 A. This is not an area in which architects are normally involved, however, there is probably no good reason why they should be excluded, as long as they have adequate background and experience, just as any registered engineer working with excavations should.
11. Page 18. Definition of "Competent Person." Should the definition be rewritten to require that the competent person be working at the excavation site?  
 A. We would consider this to be good practice.
12. Should "Mass Movement of Soil or Rock" be defined?  
 A. The term should be self-explanatory. It should include any ground movement involving volumes greater than those associated with spalling of rock, or sloughing of soil and surface erosion of soil. Perhaps the latter terms should be defined. The only place these terms appear in Subpart P is in the definition of "Fractured Rock."
13. Page 52. Old 1926.651(c): Should this statement be deleted? Even though this matter is addressed elsewhere, this statement conveys the intent of Section 1926.652 in simple language.  
 A. This statement should be deleted. It is clearly redundant with the new Section 1926.652(a).

In addition to "Some Issues that Should be Considered in the Workshops," we have some additional comments or questions.

1. Page 7. Section 1926.651(e): We feel that this requirement should apply to completed portions of excavations. This would clarify that the intent is not apply the shoring requirement in the areas where the excavation equipment is working. Substitute "completed sides" for "side" in line 4.
2. Page 7. Section 1926.651(g): Excavating equipment may be considered mobile. Is it necessary to place stop logs or barricades in front of this equipment during excavation, particularly tracked equipment or those using outriggers?
3. Page 8. Section 1926.651(p): This section currently appears to apply only to trenches. We believe exit conditions should be considered for all types of excavations. Large excavations should have a minimum of two means of exit. A second condition could be a smaller excavation of up to approximately 1500 sq ft where one exit would be permitted. A third condition would be similar to what is currently proposed.
4. Page 11. Table 1: Recognizing that many times the excavation faces are saturated only part of the way up, could we consider the soil to be type C to the top of the saturation zone and types A or B above that with the appropriate We's applied?
5. Page 11. Table 1: The Matrix Classification System shown in NBS BSS 127, June 1980, is simple to use and offers more flexibility. Would it be possible to replace in Subpart P the simplified Classification System with the Matrix Classification System, or at least offer the latter in an appendix or another section as an alternate.
6. Page 18. Section 1926.653(j): Excavation  

The draft standard does not define trench or give any criteria to distinguish between a trench or excavation as is done in the current standards. We believe this is desirable. However, it may be helpful to add a sentence to the excavation definition stating that trenches are excavations or alternatively adding a Trench definition which could state,

Trench: "One type of excavation commonly used for the installation of piping, etc."

This would provide emphasis to employers who primarily do trench type excavation work that the entire standard is applicable to their operations.

7. Page 19. Section 1926.653(1): Fractured Rock

Can rock have fractures in it and yet be considered by definition unfractured? It is rare to find especially sedimentary rock that is not fractured, yet we would consider that much of it would not readily spall or crumble when excavated with vertical slopes. We believe unstable rock would be a more suitable term for this definition.

Table 3.3 Soil Classes in Matrix Classification System

Soil	Site Condition	Water in Trench			
		No		Yes	
		Fissures		Fissures	
		No	Yes	No	Yes
Stiff Cohesive <sup>a/</sup>		I	II	III	
Medium Cohesive <sup>a/</sup>		II	III	III	IV
Granular <sup>b/</sup>		II		III	
Soft		IV		IV	

## Notes:

1. Water in Trench is assumed whenever water drains into the trench from the soil forming the bank, or water is retained by tight sheeting, or there is a possibility that the trench may become fully or partially flooded before workers leave it, or may be entered by workers within 6 hours after more than half its depth was flooded and pumped out.
2. Vibrations: Soils subject to vibrations by heavy traffic, pile driving or similar effects shall always be assumed fissured.
3. Stiff Cohesive Soils<sup>a/</sup> include stiff clays and cohesive or cemented sands and gravels (till, hardpan). Stiff clays included have an unconfined compressive strength (pocket penetrometer reading)  $q_u = 1.5 \text{ tsf}^b$  or larger.
4. Medium Cohesive Soils<sup>a/</sup> have an unconfined compressive strength (pocket penetrometer reading) between 0.5 and 1.5  $\text{tsf}^b$ .
5. Granular Soils<sup>b/</sup> are gravels, sands and silts that can stand on a slope steeper than 3 hor.: 1 vert. without spalling or slumping.
6. Fractured Rock shall be treated as granular soil. Intact rock is exempt from shoring and sloping requirements.
7. Soft Soils are cohesive soils <sup>a/</sup> with an unconfined compressive strength (pocket penetrometer reading) of 0.5  $\text{tsf}^b$  or less and granular soils that can not stand on a slope of 3 hor.: 1 vert. without slumping (much).
8. Layered Systems (two or more distinctly different soil or rock types, micaceous seams in rock) which dip toward the trench wall with a slope of 4 hor.: 1 vert. or steeper are considered Class IV soils.
9. Disturbed Cohesive Soils (backfill) shall be treated as fissured medium cohesive or soft cohesive soil.
10. Spaced Shoring Systems (skeleton sheeting or ship shoring) are permitted in stiff and medium cohesive soil with maximum center to center spacing in accordance with Table 3.3.

<sup>a/</sup> Cohesive Soils are clays (fine grained) or soils with a high clay content which have cohesive strength. They do not crumble, can be excavated with vertical sideslopes, are plastic (can be molded into various shapes and rolled into threads) when moist and are hard to break up when dry.

<sup>b/</sup> Granular Soils have no cohesive strength. They normally can not be excavated with vertical sideslopes (some moist granular soils will exhibit apparent cohesion and temporarily stand on a vertical slope), they can not be molded when moist and crumble easily when dry.

<sup>c/</sup> 1 tsf = 96 kPa



|||  
**T & B - Scottdale Contractors, Inc.**



|||  
*General Contractors*

July 7, 1981

P. O. BOX 866  
SCOTTDALE, GA. 30079  
292-7721

United States Department of Commerce  
National Bureau of Standards  
Building 226, Room 3162  
Washington, D. C. 20234

Att: Dr. Felix Y. Yokel

Dear Sir:

Mr. John Chambliss of the Georgia Branch A.G.C. has forwarded a copy of your draft memorandum on the Atlanta Workshop for my comment.

Comparing your memo with notes I made during the meeting, I believe the memo accurately states the responses to the issues raised.

Thank you for being in Atlanta with us and please accept this note as the response of the Georgia Branch A.G.C.

Sincerely,

T. P. Samford

# ASSOCIATED PUBLIC WORKS CONTRACTORS

OF GREATER MILWAUKEE, INC.

JOHN DRAKE  
Executive Director

2835 N. MAYFAIR ROAD  
MILWAUKEE, WIS. 53222  
TELEPHONE: 778-1080

June 30, 1981

Mr. Felix Y. Yokel  
United States Dept. of Commerce  
National Bureau of Standards  
Bldg. 226, Room B-162  
Washington, D. C. 20234

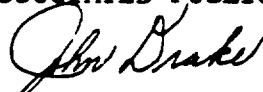
Dear Mr. Yokel:

We have received a copy of your "Memorandum for Records of the NIOSH Excavation Project" of the Workshop held in Milwaukee on June 9, 1981 and would like to express our sincere appreciation of your evaluation of many of the points that have concerned our industry since we have implemented the OSHA Regulations in our operations. Your interest in this vital matter has exhibited a very practical consideration of these problems that our important to us.

Following the meeting our committee appreciated the necessity of submitting a more detailed analysis of Chapter 6 Wisconsin Code and we are meeting with representatives of the State of Wisconsin Department of Industry, Labor and Human Relations on Tuesday, July 7, after which we will be preparing information that we will submit to you as soon as possible.

Very truly yours,

ASSOCIATED PUBLIC WORKS CONTRACTORS



John Drake  
Executive Director

JD:gs



**ASSOCIATED  
GENERAL  
CONTRACTORS**  
of Greater Milwaukee, Inc.



2733 West Wisconsin Avenue • Post Office Box 08374  
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June 30, 1981

Dr. Felix Yokel  
United States Dept. of Commerce  
National Bureau of Standards  
Bldg. 226, Room B162  
Washington D.C. 20234

RE: Draft Memorandum  
Milwaukee Workshop  
June 9, 1981

Dear Dr. Yokel:

We have reviewed your draft memorandum and feel that it accurately and concisely reflects the Milwaukee proceedings. You have covered the major areas of local concern in your memo.

We wish to take this opportunity to thank you for your consideration of our problems. You are to be commended for your excellent effort in producing data for a workable OSHA Excavating Standard.

We have forwarded your calculations for subchapter 6 to the State of Wisconsin so that they could compare them with their original data. We will keep you updated.

Sincerely,

  
Edward J. Hayden

EJH/jma

cc: Art Schmuhl  
Gil Czaplewski  
Dick Snow

August 25, 1981

Dr. Felix Yokel  
United States Department of Commerce  
National Bureau of Standards  
Bldg. 226, Room B162  
Washington, D.C. 20006

Re:     Secretarial Report  
          Trenching and Shoring Workshop  
          Milwaukee, Wisconsin  
          June 9, 1981

Dear Dr. Yokel:

We are enclosing our report of the Trenching and Shoring meeting held in Milwaukee on June 9, 1981. Attached to it are copies of the written statements received.

We wish to thank you again for coming to Milwaukee to hear our concerns and ideas and to commend you on your excellent efforts to develop an equitable standard for trenching and excavating operations.

Please feel free to contact us if we can be of any assistance to you.

Sincerely,

  
Edward J. Hayden  
Safety Director

cc:     James Elliot  
          John Ramage  
          John Drake

Enclosures

EJH/kg

### Report of the Local Sponsors Workshop

Workshop to Review and Comment on the National Bureau of Standards Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations.

June 9, 1981  
Red Carpet Inn  
Milwaukee, WI

This document constitutes the report of the local sponsors of the referenced workshop. The attendance at the workshop was as follows:

Art Schmuhl	AGC National
John Ramage	ASFE
Dr. Felix Yokel	NBS
Gary L. Dowty	AGC-Indiana
Jim Lapping	BTC-AFL-CIO
Jack Mickle	AFL-CIO
Greg Johnson	ACC
Paul Bouley	OSHA-Washington
David Schuman	S.J. Groves
Bruce Weber	Warzyn Engineering
Patrick Harrison	Milwaukee Testing
Jeffrey Miller	Giles Engineering
Kevin Foley	AFL-CIO
Roy Mururo	Laborers Local 113
James Elliott	Milwaukee Bldg. Trades
Janomiso Plocchilin	Operating Engineers #139
Russ Adam	OSHA-Region 5
Jack Peterson	OSHA-Wisconsin
Tom Crandal	OSHA-Wisconsin
George Bradberry	Underground & Shoring Service
Ed Hayden	AGC-Milwaukee
Melvin Lischefski	OSHA-Wisconsin
Fred Becker	Becker Construction
Robert Hanna	OSHA-Wisconsin
Harvey Peterson	C.G. Schmidt
Gil Czaplewski	Klug & Smith
Philip Kenny	Kenny Construction
John Drake	Associated Public Works
Walter Schmitz	Rock Contractors
Lawrence Michael	Associated Public Works
Ray Olson	Globe Contractors
Philip Santacrose	Thomasini Contractory
Kennie Hatfield	K.M. Dunn Co.
Ted Trulson	F.P. & T. Company
George Stepanik	AGC-Wisconsin

Jack Love  
Joseph Ramuta  
Jack Delaney  
Thomas Peterson  
Richard Snow  
Alan Carlson  
Milan Racic  
Robert Glukas  
Donald Zehm  
Jim Bonness  
Russell Zehetner

D & K Construction  
Michaels Pipeline Construction  
DILHR  
Johnson Brothers  
AGC-Milwaukee  
AGC-Milwaukee  
Allied Industry Workers  
Soil Testing Services  
OSHA  
Koch & Bonness  
MSS

We are attaching written copies of statements made at the meeting by:

Associated Public Works Contractors  
Rock Contractors Inc.  
S.J. Groves Inc.  
Building and Construction Trades Council  
Associated General Contractors of Greater Milwaukee

In addition we are attaching a comment received from Al Johnson Construction Company, who were not able to be represented.

The balance of the comments were oral and not submitted in writing. The workshop was recorded for reference.

As with all programs of this type, there was a wide divergence of ideas, interests and philosophies. There was, however, one point that achieved local consensus—any OSHA standard covering trenching and excavation must be clear and concise so that the workers in the field can understand what is required to provide a safe workplace and it should cover as many situations as possible with standard practices.

Other points of discussion included:

1. The use of local codes as approved substitutes without further engineering requirements Wisconsin has an existing code titled Wisconsin Administration code. Rules of Industry, Labor and Human Relations, Trench, Excavation and Tunnel Construction. In common usage this is referred to as Chapter 6. Arguments advanced for permitting its use for compliance included;

1. Its history and track record.
2. Its familiarity to both companies and employees.
3. Its use of the same size timber with various spacings depending on conditions.
4. Its allowance of 1/2 to 1 in certain soil types.

The whole crux of the discussion centers around alternatives allowed as compliance to any standard. A great many Wisconsin area people feel that existing and proven local codes should be allowable.

2. One provision of subchapter 6 must be singled out because of its number of supporters. The regulations allow a slope of 1/2 foot to one for dry or moist soils. The steepest allowable slope in the proposal is 3/4 to 1. Several speakers stated that they knew of no failure in trenches properly sloped according to Chapter 6 requirements. In metropolitan areas less slope means less disruption of existing services and facilities (roads, streets, sidewalks, utilities and lawns. It also decreases exposure time and area when working adjacent to heavily traveled roads.

3. The Consulting Engineers expressed concern over the increasing occurrence of third party liability suits. Requirements for engineers to design and oversee all trenching and shoring protective mechanisms would increase the liability of the foundation engineer. The engineers stress the need for a code that takes a reasonable approach to the involvement of the consulting engineer and their liability exposure.


4. Closely allied to the concerns of the engineers is the question of competent versus qualified persons. Part of the problem stems from a lack of understanding of the difference between the two terms. The national AFL-CIO position is that a license is required. In Milwaukee, contractors contend that a competent person i.e. "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them" is sufficient for most situations. Similarly, their definition of a Qualified Person would delete the words "by possession of a recognized degree, certificate, or professional standing or." Contractors contend that their on-the-job employees are in the best position to react to job conditions and take proper safety measures. Part of the contractor's fears about strict requirements for engineers stems from the belief that the requirements will increase the amount of "force account" work done by municipalities that have engineers on their payrolls and are not bound by OSHA requirements in any event.

5. Several parties expressed concern over standards enforcement. In particular they feel that it must be positively stated that provisions of the standard apply only to areas where there is employee exposure. If employees do not enter portions of the trench or excavation no protection should be required.

6. It was recommended that all portions of the existing standard be carefully reviewed before they are included in a new standard. For example salt calcium chloride and cil are no longer environmentally allowable methods of dust control (1926.651 i) and stop logs are impossible to use in backfilling situations (1926.652 g)

7. Dr. Yokel's study has gone a long way in analyzing what most parties agree has been a weakspot in OSHA regulations. There is however many more opposing viewpoints to be reconciled. We believe that these area workshops represent a positive advancement in the development of OSHA Standards since they give all local groups an opportunity to provide their input into future standards. This can help provide standards that are workable, viable, and effective.

  
James Elliott, Milwaukee Building Trades Council

  
John Rammage, American Society Foundation of Engineers

  
John Drake, Associated Public Works Contractors

  
Edward Hayden, Associated General Contractors of Greater Milwaukee

# ASSOCIATED PUBLIC WORKS CONTRACTORS

OF GREATER MILWAUKEE, INC.

JOHN DRAKE  
Executive Director

2836 N. MAYFAIR ROAD  
MILWAUKEE, WIS. 53222  
TELEPHONE: 778-1080

COMMENTARY BY: ASSOCIATED PUBLIC WORKS CONTRACTORS of Greater  
Milwaukee, Inc.

TO: U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU  
OF STANDARDS

WORKSHOP - JUNE 9, 1981 - MILWAUKEE, WIS.

WORKING DRAFT OF SUGGESTED REVISION IN SUBPART P OF THE SAFETY AND  
HEALTH REGULATIONS FOR CONSTRUCTION BASED ON BUILDING SCIENCE  
SERIES REPORT BSS 127 BY: FELIX Y. YOKEL.

My name is John Drake. I am the Executive Director of the Associated Public Works Contractors and have been since 1965. Prior to that I had been working as an engineer for the City of Milwaukee from 1927-1940, primarily on sewer and tunnel construction and from 1940-1965 I was superintendent and officer of 2 large sewer & WATER construction companies.

The Association appreciates the opportunity to participate in this workshop. We feel that the efforts to revise OSHA Rules and Regulations are very important to the industry not only for the safety, but for the economics involved.

Since 1935 this Association's members have performed the bulk of the sewer, water and utility work in the State of Wisconsin.

In 1952 we were pleased to have participated with other elements of the construction industry to assist in developing the WISCONSIN ADMINISTRATIVE CODE, Rules of Industry, Labor and Human Relations, Trench Excavation and Tunnel Construction Code Section 6.01, parts of which are attached. We are proud to advise you of the fact that not a single injury or fatality has occurred with the use and utilization of the WISCONSIN CODE Chapter 6.

We respectfully request and suggest that this Code, with the accompanying tables, be considered at least equal or superior to the present OSHA requirements and become a part of them.

With respect to the draft recommendations of The National Bureau of Standards we have the following comments on the issues to be considered for the workshops on page 3:

1. We feel that no change is necessary.

2. Yes, 5' rather than 4'.  
Yes, exit requirements should be waived.  
Yes, large enough pipes should be recognized as shelter.  
Definition, "negotiable slope" is satisfactory.
3. Yes, we feel the depth limit could be, in standard practice, extended to 24'.

A qualified person should be substituted for an engineer.

4. Yes, 7 days should be considered rather than 1.
5. We definitely feel the maximum slope should not be limited to three-quarters to one.

The suggested performance requirement should be used; it is a workable approach.

6. Yes, we agree the allowable bank should be increased.  
Excavation should not be limited to trenching machines.
7. No comment.
8. Yes, we agree with more options on proposed performance statements.
9. Yes, we certainly agree that the excavation of the bottom of shoring shields be increased to 3' or more under proper conditions.

10. Yes, a registered architect should be omitted.
11. Our operation requires that competent people be employed.  
We feel the judgment of the degree of competency should also be extended to the enforcement officer.
12. Yes, mass movement of soil or rock should be defined.
13. Yes, it should be deleted.

In general we would also like the workshop to emphasize:

1. A reasonable evaluation of sloping. This is probably one of the biggest items to be considered. The history of this industry indicates that predetermining a slope is practically an impossibility. This is where the proper, competent person's judgment should be considered more valuable than textbook calculated slopes. Certainly the necessity of bracing shallow trenches, those below 5', in many instances, is most impractical and a costly item.



June 9, 1981

2. The predetermining of the depths, whether 20 or 24', is again very difficult to predetermine because of the varying soil conditions and other circumstances.
3. A very important item is the practical evaluation of the "timbering" and bracing of trenches. The variation of "timbering" sizes in OSHA although calculated to provide the right support, is not practical. The more practical installation would be uniform timber sizes with variation of spacing.
4. The greater majority of our work is under "short term excavation." Restricting this to 1 day would be most impractical and we feel the extension to 7 days is important.
5. The consideration of the depth below "shields" is a very important item. An evaluation of the specific job being constructed and the soil conditions should certainly determine the allowable distance below the shield.

We realize the concern, not only of our industry, but our entire country regarding the necessity of safety standards. We also appreciate your making this attempt to make the standards for our industry not only to provide a safe place for our men, but to also safeguard the industry.

Thank you, very much, for this opportunity to speak, not only for myself but for our members.

John Drake, Executive Director  
Associated Public Works Contractors

TABLE 4—TRENCH TIMBERING REQUIREMENTS

For trenches over 42 inches in width up to and including 12 feet in width

Depth of Trench	Uprights	Cross Braces	Stringers
Over 4 1/2 ft. to 10 ft. incl.	(*)	6x6 inch timbers spaced horizontally 7 ft. face to face	6x6 inch timbers spaced 4 ft. c-c
		6x6 inch timbers spaced horizontally 11 ft. face to face	6x6 inch timbers spaced 4 ft. c-c
Over 10 ft. to 20 ft. incl.	(*)	6x6 inch timbers spaced horizontally 7 ft. face to face	6x6 inch timbers spaced 4 ft. c-c
		6x6 inch timbers spaced horizontally 11 ft. face to face	6x6 inch timbers spaced 4 ft. c-c
Over 20 ft. to 30 ft. incl.	(*)	6x6 inch timbers spaced horizontally 7 ft. face to face	6x6 inch timbers spaced 3 ft. c-c
		6x6 inch timbers spaced horizontally 11 ft. face to face	6x6 inch timbers spaced 3 ft. c-c
Over 30 ft. to 40 ft. incl.	(*)	6x6 inch timbers spaced horizontally 7 ft. face to face	6x6 inch timbers spaced 3 ft. c-c
		12x12 inch timbers spaced horizontally 11 ft. face to face	12x12 inch timbers spaced 3 ft. c-c

(\*) Uprights shall consist of 2 inch planks and spaced to comply with specifications for trenches less than 42 inches in width.

TABLE 5—TRENCH TIMBERING REQUIREMENTS

For trenches 4 1/2 to 15 feet in depth, 3 1/2 to 12 feet in width, and cut in hard soil\*

Depth (ft.)	Width (ft.)	Uprights	Cross Braces
4 1/2 - 8	3 1/2 - 12	2x6 inch planks spaced 4 ft. c-c	2—2x6 inch struts spaced 4 ft. c-c
8 - 12	3 1/2 - 12	2x6 inch planks spaced 4 ft. c-c	3—4x6 inch struts spaced 4 ft. c-c
12 - 15	3 1/2 - 12	2x6 inch planks spaced 4 ft. c-c	4—4x6 inch struts spaced 4 ft. c-c

\*In case unstable soil is encountered, bracing shall immediately revert back to that called in Table 4.

History: Cr. Register, December, 1962, No. 84, eff. 1-1-63; am. (1) (intro.), (6) and (9), Register, September, 1976, No. 572, eff. 10-1-76.

Register, September, 1976, No. 572  
Trench, Excavation and Tunnel Construction

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**Wisconsin  
Administrative Code  
Rules of  
INDUSTRY, LABOR AND HUMAN  
RELATIONS**

**TRENCH, EXCAVATION AND  
TUNNEL CONSTRUCTION**

Cite the rules in this Code as

(for example)

Wis. Adm. Code section Ind 8.01  
INDUSTRY, LABOR AND HUMAN RELATIONS  
201 East Washington Ave.  
Madison, Wisconsin 53702

**Part II**

**TRENCHES AND EXCAVATIONS**

Ind 8.06 Timbering requirements and procedures for trenches and other excavations. (1) **BRACE OR SLOPE.** All areas in trenches in which persons are permitted to work shall be adequately and securely timbered or sloped as follows.

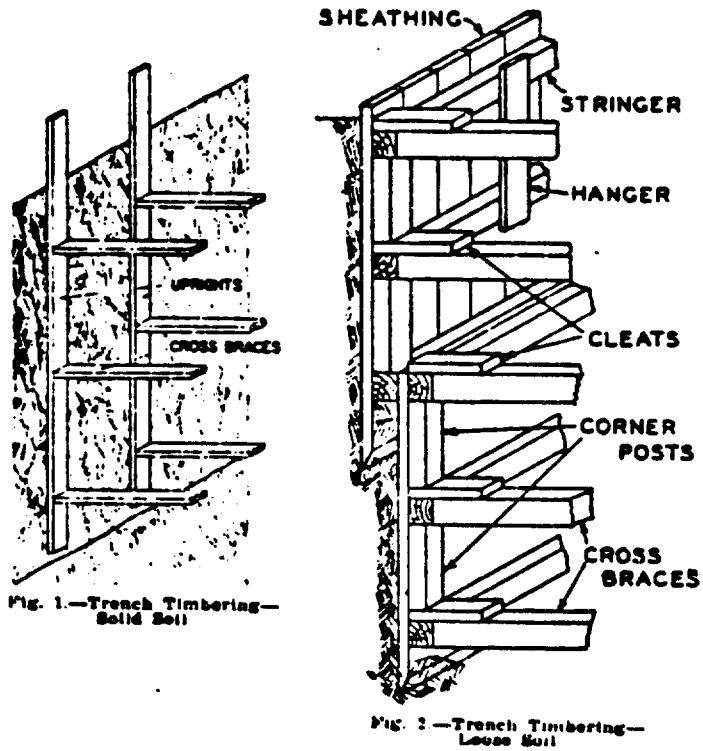
(a) **Depth. Exception.** Trenches cut in hard solid soil need not be braced or sloped if less than 4½ feet in depth. Trenches cut in loose or sandy soil need not be braced or sloped if less than 3 feet in depth.

(b) **Rock. Exception.** Trenches need not be timbered if excavated in solid rock and if there have been no previous known excavations within the minimum lateral distance of the depth of the trench being excavated. The total depth of the trench must be in rock or any over burden must be sloped or braced.

(c) **Sloping. Exception.** Trenches need not be timbered if the sides are cut down to the angle of repose. The angle of repose shall not be considered greater than one to one-half (measuring one foot of rise to each ½ foot horizontal) for dry or moist soils and not more than one to one for wet or heavy soils.

(2) **PARTIAL SLOPE AND BENCHES.** When the sloping of trench walls to the angle of repose does not extend to the bottom of the trench, level benches 2 feet wide shall be provided between the toe of the slope and the top edge of the vertical walls. The vertical part of a partially sloped trench shall be braced according to its vertical depth below the bench. If benches are not provided as in case of the necessary trimming back of loose material at the surface, the trench shall be braced according to its

Register, September, 1975, No. 273  
Trench, Excavation and Tunnel Construction



Register, September, 1978, No. 973  
Trench, Excavation and Tunnel Construction

**TABLE 2—TRENCH TIMBERING REQUIREMENTS**  
For trenches over 10 feet and not exceeding 15 feet in depth and width not exceeding 42 inches

	Kind of Soil	Uprights	Cross Braces	Stringers**
Where no parallel excavations exist or have existed within 15 ft.	Hard, solid soil	2x6 inch planks spaced 4 ft. c—c	*3—2x6 inch planks or equivalent for depth under 13 ft.; 4 for depths 13 ft. to 15 ft.	None
Previous excavations 10 to 15 ft. from trench	Hard, solid soil	2x6 inch planks spaced 3 ft. c—c	*3—2x6 inch planks or equivalent for depths under 13 feet; 4 for depths 13 ft. to 15 ft.	None
Previous excavations less than 10 ft. from trench	Hard, solid soil	2x6 inch planks spaced 2 ft. c—c	*3—2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.	None
Irrespective of any previous excavations	Soil that splits easily	2x6 inch planks spaced 2 ft. c—c	*3—2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.	1x6 inch boards placed back of uprights near top of trench
Irrespective of any previous excavations	Sand, gravel filled in ground or very wet soil	2 inch tight sheathing	3x6 inch timbers or equivalent, spaced 6 ft. c—c	6x6 inch timbers or equivalent—3 for depths under 13 ft.; 4 for depths 13 ft. to 15 ft.

Notes—c means center to center

\*In lieu of these cross braces for each upright, 3x6 inch stringers may be used with substantial cross braces spaced horizontally sufficient to give equivalent protection, but in no case exceeding 6 feet.

\*\*Stringers shall be properly supported by posts or cleats.



# ROCK CONTRACTORS, INC.

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COMMENTARY ON SUGGESTED REVISION IN SUBPART P  
OF THE SAFETY AND HEALTH REGULATIONS FOR  
CONSTRUCTION BASED ON BUILDING SCIENCE SERIES  
REPORT BSS 127

U. S. DEPARTMENT OF COMMERCE  
NATIONAL BUREAU OF STANDARDS  
WORKSHOP - JUNE 9, 1981  
MILWAUKEE, WISCONSIN

GENTLEMEN:

MY NAME IS WALTER P. SCHMITZ, PRESIDENT OF ROCK CONTRACTORS, INC.  
287 - 27TH STREET, CALEDONIA, WISCONSIN. I AM A REGISTERED  
PROFESSIONAL ENGINEER WITH A MASTER OF SCIENCE DEGREE IN CIVIL  
ENGINEERING. I HAVE HAD 33 YEARS OF EXPERIENCE IN THE DESIGN AND  
INSTALLATION OF UNDERGROUND IMPROVEMENTS UTILIZING TRENCH EXCAVATION  
AND TUNNEL CONSTRUCTION. I PREVIOUSLY WAS ENGINEER - IN - CHARGE  
OF CONSTRUCTION FOR THE CITY OF MILWAUKEE, RESPONSIBLE FOR ALL  
SEWER, WATERMAIN, AND PAVEMENT CONTRACT CONSTRUCTION IN THE CITY.  
I ALSO AM A PAST PRESIDENT OF THE ASSOCIATED PUBLIC WORKS  
CONTRACTORS ASSOCIATION OF GREATER MILWAUKEE AND A PAST PRESIDENT  
OF THE MUNICIPAL ENGINEERS ASSOCIATION. FOR A NUMBER OF YEARS I  
WAS CHAIRMAN OF THE CITIZENS'S ADVISORY COMMITTEE FOR REVISIONS TO  
THE TRENCH, TUNNEL AND CAISSON BRACING REQUIREMENTS OF THE STATE  
OF WISCONSIN ADMINISTRATIVE CODE.

INCORPORATED 1954

AFTER REVIEWING THE PROPOSED STANDARDS, I AM PARTICULARLY CONCERNED WITH TWO AREAS. THE FIRST IS TRENCH SLOPING AND THE SECOND IS TIMBERING REQUIREMENTS FOR TRENCHES, SHAFTS, AND TUNNELS. I AM CONCERNED FOR TWO REASONS - FIRST, THE ACTUAL SAFETY OF OUR MEN WHO WORK IN THE TRENCHES - SECONDLY, THE PRACTICAL APPLICATION OF THE STANDARDS TO THE TYPES OF SOIL IN WISCONSIN AND THE MATERIALS AVAILABLE TO US FOR BRACING AT A REASONABLE COST IN OUR STATE.

CHAPTER 6 OF THE WISCONSIN ADMINISTRATIVE CODE OF THE DEPARTMENT OF INDUSTRY, LABOR AND HUMAN RELATIONS HAS BEEN USED FOR APPROXIMATELY THIRTY YEARS FOR TRENCH EXCAVATION AND TUNNEL CONSTRUCTION BRACING REQUIREMENTS. DURING THIS TIME IT HAS HAD A REMARKABLE RECORD OF PERFORMANCE. DURING MY 33 YEARS OF DEEP INVOLVEMENT IN THE INDUSTRY, I AM UNAWARE OF ANY ACCIDENT OR INJURY CAUSED BY THE FAILURE OF THE SLOPING AND BRACING REQUIREMENTS OF THIS CODE.

ACCIDENTS AND INJURIES DO OCCUR DURING BRACING INSTALLATION AND I SEE NUMEROUS REQUIREMENTS OF THE NEW STANDARDS WHICH WILL LEAD TO A POSSIBILITY AND PROBABILITY OF INJURIES. TIME AVAILABLE TO ME WILL NOT ALLOW DETAILING THESE AT THIS TIME, BUT I WILL BE PLEASED TO HELP IN ANY CONFERENCE WITH THE BUREAU TO DISCUSS THESE PROBLEMS.

BECAUSE OF THE REMARKABLE SAFETY PERFORMANCE OF CHAPTER 6 OF WISCONSIN'S ADMINISTRATIVE CODE, I IMPORE THE BUREAU OF STANDARDS AND THE DEPARTMENT OF LABOR TO ALLOW THE FOLLOWING SECTIONS OF THE CODE TO BE ALLOWED TO BE USED AS AN "EQUAL OR SUPERIOR" ALTERNATIVE FOR USE IN WISCONSIN TO THE PROPOSED OSHA STANDARDS. THESE SECTIONS ARE:

PART II IN ITS ENTIRETY

PART III TABLE 6, TABLE 7  
IND 6.12 THROUGH 6.22 INCLUDING  
FIGURES 3 THROUGH 12.

A CAREFUL APPRAISAL OF THE RECORDS OF THE WISCONSIN DEPARTMENT OF  
INDUSTRY, LABOR, AND HUMAN RELATIONS WILL SUPPORT THE FINE SAFETY  
RECORD I HAVE REFERRED TO AND WE HOPE THE DEPARTMENT OF LABOR WILL  
SEE FIT THROUGH THE BUREAU OF STANDARDS RECOMMENDATION TO ALLOW  
THE SUGGESTED ALTERNATIVE. I AM ABSOLUTELY CERTAIN INJURIES AND  
DEATHS WILL BE PREVENTED.

THANK YOU FOR YOUR SERIOUS CONSIDERATION OF THIS RECOMMENDATION.

SINCERELY,  
ROCK CONTRACTORS, INC.



Walter P. Schmitz, President



TO

FROM

Mr. Edward J. Hayden  
The AGC of Greater Milwaukee  
P.O. Box 08308  
2733 West Wisconsin Avenue  
Milwaukee, WI 53208

S. J. GROVES & SONS CO.  
P. O. Box 2009  
Springfield, Illinois 62705  
Telephone (217) 787-2484

SUBJECT Comments for the workshop on suggested revision in 29 CFR 1926, Subpart P

DATE 10 June 81

Dear Ed,

The attached list of comments, presented at the workshop June 9, 1981, is for your record. Inasmuch as this was the first of the workshops on this subject, I feel there is no real evidence which would support the change to the existing regulations. Thanks again for the opportunity to present our views on the matter.

David L. Shuman

FORM 1-65 (REVISED FEBRUARY 1965)

SPEED-MEMO

- 1) THE CURRENT STANDARDS ALLOWS THE PROTECTION REQUIRED FOR THE EMPLOYEES, BY THE EMPLOYER, FREE OF HAZARDS.
- 2) THE RECOMMENDED CHANGES WILL INCREASE COSTS TO PERFORM THE WORK, WHICH WILL ADVERSLY AFFECT OWNERS (TAXPAYERS)
- 3) THE EXISTING REGULATION ARE SOUND AND IF WE ACCEPT A CHANGE OF THIS TYPE IT WILL DEVELOPE AN AREA OF LIABILITY WHICH STILL DOES NOT RELEIVE THE EMPLOYER OF THE RESPONSIBILITY OF PROVIDING A SAFE AND HAZARD FREE WORK ENVIRONMENT.
- 4) NEW REGULATIONS DO NOT ALLOW ACCEPTED INDUSTRY PRACTICE.
- 5) HAS INDUSTRY HAD ANY SERIOUS PROBLEMS WITH TABLE P-1, IN EXISTING REGULATION ?
- 6) THE NEW REGULATIONS WILL PLACE STRINGENT CONDITIONS ON SMALL BUSINESS, UNLESS THE CONTRACT IS AWARDED UNDER SECTION 8(a) (COST PLUS) OF THE SMALL BUSINESS ACT.
- 7) THE RECOMMENDATIONS DO NOT SHOW ANY COST EFFECTIVE BENEFIT.
- 8) WILL OSHA INSPECTORS BE ABLE TO UNDERSTAND THE REGULATIONS AS PROPOSED, AND PROPERLY INSPECT ?

**DRAFT**

DISCUSSION OF:

WORKING DRAFT OF SUGGESTED REVISION IN SUBPART P OF  
THE SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION  
BASED ON BUILDING SCIENCE SERIES REPORT BSS 127

by Felix Y. Yokel

by

BUILDING AND CONSTRUCTION TRADES DEPARTMENT AFL-CIO

JACK L. MICKLE

MILWAUKEE, WISCONSIN

JUNE 9, 1981

# DRAFT

Dr. Yokel is to be commended for his efforts to improve upon the Occupational Safety and Health Administration, (OSHA), 29 CFR Part 1926. Subpart P, Excavation, Trenching and Shoring Regulations document.

The Building and Construction Trades Department, AFL-CIO has been supportive of and assisted Dr. Yokel, where possible, since he began work on this project with the National Bureau of Standards in June, 1976.

In January, 1977 the B&CTD began the planning stage of a "Trenching Hazard Identification Task Force", hereinafter called the Task Force, to help the NBS obtain employee input aimed at hazard identification. In March, 1977 the Task Force met for a four day "retreat" type workshop; the six labor and management members brought with them 182 years of experience in trenching and related work. The charge was "to identify procedures and conditions that create safety hazards during excavation and trenching operations". Others present for the deliberations were Jim E. Lapping, Director of Safety and Health, B&CTD, as coordinator; Felix Y. Yokel as Technical Observer for the NBS and Jack L. Mickle, Chairperson. The final report (1)\* was filed with the NBS in April, 1977. The final report appears in appendix G of NBSIR 80-1988 (2).

In September, 1978 Dr. Yokel (3) presented the preliminary findings and recommendations of the NBS study. Out of that two-day workshop came the agreement for this series of workshops to bring the results of Dr. Yokel's NBS study to the attention of labor, management and engineers in the field. Actually the essence of the working draft we are using for this workshop was printed in the Concrete Pipe News (4) in April of this year.

Since the 1978 workshop the B&CTD has responded to a number of requests for criticisms of drafts by Dr. Yokel.

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\* Numbers in parentheses refer to references given at the end of this paper.

Two premises underlie all remarks and criticisms given in this critique:

That the worker be assured of safe and healthful working conditions, and

that the journeyman worker and the compliance officer as well as the management representative be able to fully understand the precautions that have been taken and the protective measures that have been provided to assure worker safety and health, or that the safety of the worker on the job be placed in the hands of a licensed professional.

The first premise is spelled out in the preamble of the Occupational Safety and Health Act of 1970.

The second premise assumes that an average journeyman or compliance officer, using the official OSHA regulations governing excavation and trenching safety, can determine whether or not the safety provisions on any jobsite are in compliance with the appropriate regulations. If the provisions are not "standard practice" as outlined in the regulations then there must be a certificate issued by a licensed professional which assures the worker that the jobsite safety and health measures have been designed by and certified by the licensed professional.

There are undoubtedly many "competent persons" and qualified persons" who are quite capable of designing a safe worksite, but how are they to be identified by the worker or compliance officer? The license is the evidence. All licensing laws have encountered competent or qualified persons and have eventually incorporated them into or excluded them from practice. While there are probably quite capable people who know a great deal about medicine or law, the prudent individual seeks the licensed practitioner when medical or legal opinions or services are sought.

Actually suggesting that registered engineers need to be consulted is not new with this suggestion. Thompson and Tanenbaum (5) recommend substantial involvement of registered engin-

11

**DRAFT**

vers in construction activities requiring trenching or excavations.

In view of the foregoing, this discussion will be concerned with only the first 20 pages of Dr. Yokel's working draft which outlines "standard practice". Even portions of the first 20 pages probably belong in the "guidelines" which have been included to assist professionals. It is also assumed that only the "standard practice" will eventually be recommended for inclusion in the OSHA regulations Subpart P; Dr. Yokel has indirectly suggested that by what was included in the article which he co-authored in the Concrete Pipe News.(4).

# DRAFT

## COMMENTS ON SELECTED ITEMS ON PAGES 1-20 OF THE WORKING DRAFT

### Page Location Comment

1	item 3	"boxes. It is addressed to contractors, shoring manufacturers and engineers..." Why address it to the contractor unless the contractor is also an engineer?
2	item 5	"...which would aid field personnel and contractors in the selection of shoring." Once again, these persons are going to be dealing with the standard practice unless they are licensed professionals in their own right.
2	last line	Note that a qualified person is not an engineer (recognizing this as just an example)
3&4	All Issues	The items listed on pages 3 and 4 will be considered individually as they encountered in the text.
5	(g)	..be provided with and shall be instructed (required) to wear ....
5	(i)	...shall be permitted under loads handled by <del>power-shovels, derricks, or hoists</del> (equipment) This item is too specific for not listing all equipment which is used to handle loads; for example, backhoes are not listed.
6	(j) 2nd para. line 8	...or the shoring system, and shall increase <del>protection against slides and cave-ins if necessary</del> (see that all work in the excavation shall cease until necessary precautions have been taken to safeguard employees.)
6	(c)(1) line 3	"..shall be effectively stored and retained at least 2 (3) feet or more from the edge of the excavation." The Task Force specifically stated that 3 feet was necessary for proper protection.
6	(c)(2) line 3	"...may use effective barriers <del>or other effective retaining devices in lieu thereof</del> in order..." Task Force recommended extending tight sheeting above ground level as an effective barrier. Twelve to 18 inch extensions were discussed.
8	(l) line 2	"... equipment, they shall be <del>designed and constructed</del> by qualified persons..." Design implies work done by a licensed professional.
8	(o)	This item is silent with respect to straight sided pier holes; some confusion has arisen because 1926: straight sided holes are covered elsewhere. 800(h)(3)
8	(p)	When employees are required to be in trenches 4 <del>(5)</del> feet deep...." Leave at 4 feet.

# DRAFT

Page	Location	Comment
8	(s)	"...boxes or shields are used they shall be designed (and certified as to use by a professional engineer and shall be maintained in a manner which will provide protection for the worker.)" Strike the balance of (s).
9	(a)(1)a	Excavations less than 5 ft. deep, except when examination-of-the-ground-by-a-competent-person-indicates-that hazardous ground movement may occur."
9	(a)(2)	"Excavations from 5 ft. to 20 ft. <del>(24-ft.-2)</del> deep.." Why consider 24 feet? A better choice might be 15 feet for standard practice. Thompson and Tanebaum data (5) indicate that 87 per cent of the fatalities and injuries occur in excavations less than 20 feet deep and that 2 per cent occur in those less than 15 feet deep. Hinze and Carino (2) state in their summary that their "...study showed that most trenchwork is between 5 and 15 feet deep with the trench width usually being about 3 feet." Cass (6), speaking about the stacking of two standard 7 ft. aluminum hydraulic shores, notes that where the trench is over 14 feet deep (page 68) "other shoring systems should be applied" and on (page 72) "Maximum trench depth, this method, is 15' (4.58 m). Over 15' (4.58m), see Fig. 60.2, multi-type shoring." Multi-type shoring shown on Fig 60.2 is a different system using aluminum hydraulic shoring and plywood backing. A maximum depth of 15 feet for standard practice seems appropriate.
9	(a)(2)a line 3	"...sloping requirements must be determined by an engineer <del>(a-qualified-person?)</del> ."
9	(a)(2)b Figure 1	May lead an individual to believe that FOOTING A is not a cause for concern; this could be dangerous. It is worthy of note that the role of the engineer has not been challenged at this point where property damage as well as personal injury is possible.
10	(a)(3)	See comments under: page 9 (a)(2). Fifteen ft. depth may be a better limit for standard practice rather than 20 ft.
10	(b)(1) line 6	The distinction between short-term and long-term is very difficult to reckon with; virtually no firm data exists. Not only stresses in the mass vary with time, but environmental factors may be critical. Twenty-four hours seems more logical than seven days.



# DRAFT

Page	Location	Comment
11	bottom of page last two lines	There may be some merit to allowing steeper slopes in some cases. The Task Force indicated that slopes flatter than 1:1 were probably not necessary for worker safety. Slopes of 1:1 were recommended for most conditions.
12	Fig. 2 Case IV	This particular configuration should be made a part of the "guidelines" proposed by NBS. While the configuration looks good on paper, it may be difficult to understand and/or enforce in the field. If included in standard practice the 3 ft. max bank should be retained.
13	(b)(4)(i)b.	See the first four lines at the top of page 13. Table 2 is necessary in standard practice only if Fig. 3(b) is retained. Moving the option shown as Fig. 3(b) to the guidelines removes the need for Table 2 which is confusing and also removes the need for special tables and figures outlining the placement of shoring in the lower part of the ditch.
13	(b)(4)(i)c.	For standard practice it may be worthwhile to include all surcharges, including allowances for heavy equipment, in the adjusted depth. The Task Force recommended a minimum of 300 pounds per square foot for surcharge. Dr. Yokel has greatly simplified Table 3 but it still can be confusing. Moving Table 3 to the guidelines and greatly increasing the surcharges to allow for heavy equipment may lead to "overdesigned" shoring and shields, but standard practice would thereby be greatly simplified.
13	(ii)b.	The Task Force recommended a 500 lb gravity load.
13	(ii)c.	This statement is not clear. Does this mean a 240 ft-lb impact load per square foot? The entire (ii)c. should become a part of the guidelines and removed from standard practice.
13	(ii)	This entire section devoted to the required strength of shoring systems, trench shields and trench boxes needs to be moved to the guidelines.
16	b.	If some of the previous suggestions are followed, hydraulic shores and other assemblies can be brought into standard practice. At a meeting in October, 1980 with NBS and members of the hydraulic shoring industry it was agreed that reasonably simple charts for the selection of shores can be developed. This seems to be in keeping with Cass' (6) recommendations for depth to 14 or 15 ft. There is no question that the resulting system would be greatly over-designed

Page	Location	Comment
		at times, but the freedom to use standard practice for most work (2) and thereby not requiring the services of an engineer seems to outweigh the disadvantages of overdesign.
16	c.	Timber shoring is properly located in the guidelines; selection must be by an engineer. The guidelines are for the use of licensed professionals.
16	(5)(ii) last two lines	The statement in parentheses is a vague performance specification which detracts from a well stated, precise paragraph.
16	(5)(iii)	Excavation below the bottom of bottom of the protective element has merit; exactly how much to allow is difficult to determine. Certainly engineers can design specific protection for unique circumstances, the guidelines will help, but permitting excavation below the protection device in standard practice will require very careful consideration.
18	(a)	"...with standards required by a-registered-architect, a registered professional engineer, or other duly licensed or-recognized authority. ..."
19	(m)	Twenty-four hours for short term seems most reasonable.
19	(o)	Negotiable slope needs to be specified; 1½:1 seems reasonable.
19	(n)	How is a qualified person to be identified? Unless there is a specific procedure anyone can claim to be a qualified person. No objection is the qualified person is permitted to use standard practice only.
19	(t)	same argument; use 24 hours for short term.
19	(aa)	<u>Stable Slope</u> . A meaningless term unless it is arrived at by a licensed engineer. This term has no place in Standard Practice!
20	(gg)	Working loads are best relegated to the guidelines where they can be dealt with by an engineer.

# DRAFT

## Summary

There must be clear separation between Standard Practice and cases where an engineer has certified the procedure to be followed.

It is recommended that Standard Practice be permitted to a depth of cut of 15 feet; this includes most excavation and trenching work. At depths greater than 15 feet, or for special work, the engineer must assume full responsibility for the design of the protective system. The 15 ft. depth needs verified.

Standard Practice must be written such that the protective measures resulting from the application of Standard Practice are observable, measurable, understandable by all parties (with application of the regulations) and provide for the safety and health of the worker. It is recognized that Standard Practice may at times result in substantial overdesign, but this would not be new to the construction field.

It is anticipated that competent or qualified persons working for the contractor would select methods within Standard Practice to protect workers, but that any deviation from Standard Practice would need to be designed by an engineer. The engineer is recognizable by a professional license.

Several items which need consideration: construction right of way requirements, toxic materials, safety program as an item in the bid document, soil conditions and utilities in the bid document and better safety education for all. The Task Force final report lists other concerns.

DRAFT

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**ASSOCIATED  
GENERAL  
CONTRACTORS**  
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**Associated General Contractors of Greater Milwaukee**

**Statement for the Workshop on the National Bureau of Standards  
Recommended Technical Provisions for Construction Practice in  
Shoring and Sloping of Trenches and Excavations.**

**June 9, 1981**

The Milwaukee Construction Industry Safety Council is a co-operative effort originated and administered by the AGC of Greater Milwaukee. As such we aid in the safety programs of 800 area construction firms.

In answer to the specific issues outlined in the working draft we take the following position.

1. We feel that 1926.651 (a) is pertinent to a trenching and shoring standard. Most underground services are located in shallow trenches. Any excavation below 18 inches can encounter buried utility lines. Many states have laws requiring utility notification.
2. We believe that exit requirements should begin at five feet. Observation indicates that working crews seldom use available ladders unless the excavation is over five feet deep anyway. Using five feet would cause a well defined trigger point for action since it correlates directly with the start of trenching and shoring requirements.

It is indisputable that larger excavations allow effective escape to the center in case of collapse. Consideration should be given to the use of this method. The same is true of large pipes or other covered structures.

3. We feel that "qualified person" should be substituted for "engineer". The actual work crews are in the best position to judge the situation. Qualified on the job supervision should be sufficient for everyday situations. We feel that you have developed a workable definition of "qualified person".

4. The concept of short term vs. long term excavation is a difficult one to deal with. The stability of the sides of the excavation is more a function of climate and other factors than the length of time an excavation remains open.
5. The State of Wisconsin allowed a slope of 1/2 to one for dry or moist soils in its old code. The code was in existence for over 30 years. We know of no incidents of a failure in a trench sloped according to Wisconsin's code. We would request that you investigate the validity of the 1/2 to 1 slope for some situations. Its use in Wisconsin would indicate that it does offer adequate employee protection. The advantages are obvious. Less material is excavated with less disruption to existing roads, driveways, lawns, sidewalks, buildings and utilities. A performance standard allowing 1/2 to 1 might be a viable alternative to this proposal.
6. We have not taken a formal position on this question.
7. 1926.652 (b) (;;) is not appropriate for use by the person in the field. We appreciate the necessity of including it in any standard and concur that it would be better if placed separately in the standard and/or transferred to definitions.
8. Workers must be protected from objects rolling or sliding from sloped ground. We do not believe that how this protection is accomplished should be specified. The employer and employees should be allowed great latitude in methods of providing this protection.
9. Most stress appears to be in the middle of a trench. We know of no safety reason why a shield cannot ride at least 3 feet up from the bottom in good or average soils.
10. We support the deletion of architects from the list of "accepted engineering requirements.
11. We believe that a competent person should be on the jobsite.
12. Begining a mass movement of soil or rock does not appear to be necessary.
13. Old 1926.651 (c) can be eliminated since it is adequately covered elsewhere.

**ASSOCIATED  
GENERAL  
CONTRACTORS**  
(of Greater Milwaukee, Inc.)

We also wish to address other areas in the proposed standard. On page seven 1926.651 (g) the use of stop logs is required. This is not practical for backfilling operations or for installing bedding in long trenches.

1926.651 (i) covers the methods of keeping down dust. The application of large amounts of salt, calcium, chloride, and oil is not always an environmental sound dust control option.

On page 17 two tables appear (4a and 4b) that serve the same purpose. We suggest that 4a be eliminated and all spacing be done on a center to center basis.

We favor a standard that permits the use of accepted engineering codes and practices for the installation of shoring. This allows for the use of charts on the site as a guide to installing safe shoring.

We are concerned about the practical applications of the standard. No contractor has a complete lumberyard on the site. He can effectively protect his employees by using the same sizes of timber in a different depths and soil types. This can be accomplished by decreasing the spacing and increasing the number of struts. Forcing contractors to use excessively large timbers will result in more back injuries. Greater than necessary sloping requirements means more exposures to traffic hazards in the metro area where most trenching is done.

We support a practical standard that effectively protects employees without being economically burdensome. We believe this study is making excellent progress in this regard.

AL JOHNSON CONSTRUCTION CO.

*General Contractors*

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Telephone : 612/831-8181

June 5, 1981

Edward J. Hayden  
AGC of Greater Milwaukee  
P.O. Box 08308, Milwaukee, Wi.

RECEIVED  
JUN - 8 1981  
AGC-MILWAUKEE

Re: "WORKSHOP", Trenching & Shoring Std's.

Hi Ed,

I have no plans for attending the June 9th session, your city, but from confidence that you'll be a participant, I take this action.

On three separate occasions, I've made a close review of the "working draft of suggested revisions for Subpart P, 1926, OSHA". Overall, I consider the document much superior to present form and probably as realistic and comprehensible as might be developed.

The enclosed set of copy sheets from certain pages of the "draft" include my markings from reviews... Maybe in this way, and through you, I might contribute to a consensus opinion, even though trenching-work is almost non-existent in our operations.

Best Regards,

M. O. Dumas

end.

P.S. — Thanks for the regular mailings  
of "For Safety's Sake"



SOME ISSUES THAT SHOULD BE CONSIDERED IN THE WORKSHOPS:

1. Page 6. Section 1926.651(a): This section appears to fall within the scope of Subpart S. Should it be dropped? NO
2. Page 8. Section 1926.651(p): Should the exit requirements for excavations start at 5 ft, rather than 4 ft depth? NO  
(This would remove most excavations less than 4 ft deep from the scope of Subpart P.) Should exit requirements be waved for excavations which are wide enough to permit people to escape toward the center of the excavation? Should it be recognized that large enough pipes or other covered structures can shelter people? Should "negotiable slope" be better defined? yes
3. Page 9. Section 1926.652(a)(2): Could the depth limitation in the "Standard Practice" be extended to 24 ft? If so, should there be a more stringent limit for Class C soils? Should a "qualified person" be substituted for an "engineer", and if so, is the definition of a "qualified person" good enough so that a determination of who is a "qualified person" is possible? (This issue also applies to other sections of the working draft.) no
4. Page 10. Section 1926.652(b)(1): Should the short-term excavation definition extend to 7-days rather than 1-day? If so, do we need more conservative requirements? NO
5. Page 11. Table 1: Should the stipulation of maximum slope be limited to 3/4:1? Should the suggested performance requirement (footnote b) (the "stable slope" concept) be used? Will this approach work? yes
6. Page 12. Figure 2: Should the allowable bank next to the work area in Cases II, III and IV be increased to 4 ft? Should "Case IV" be limited to excavation by trenching machines? no
7. Page 13. Section 1926.652(b)(4)(ii): This section, unlike most others in Subpart P, is not addressed to the man in the field, but to those who pre-design shoring systems. Yet the section is necessary to avoid unreasonable vagueness. Should this section be at the end of Subpart P? Should part of it be conveyed as definitions? yes

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- OK  
as drafted
8. Page 16. Section 1926.652(b)(5)(ii): This section makes it difficult to implement some of the slope configurations allowed in Fig. 2. Should the proposed performance statements be substituted to give more options, or alternately, should more options be specified or the specified options identified as examples of implementing the performance statement?
9. Page 16. Section 1926.652(b)(5)(iii): Should the allowable excavation below the bottom of shoring or shields be increased to 3 ft? *yes*
10. Page 18. Definition of "Accepted engineering requirements" Should "a registered architect" be omitted since architects do not deal with excavations? *yes*
11. Page 18. Definition of "Competent Person": Should the definition be re-written to require that the competent person be working at the excavation site? *yes?*
12. Should "Mass Movement of Soil or Rock" be defined? *no*
13. Page 52. Old 1926.651(c): Should this statement be deleted? *No* even though this matter is addressed elsewhere, this statement conveys the intent of Section 1926.652 in simple language.

SUBPART P - EXCAVATIONS AND SHORING

1926.650-GENERAL PROTECTION REQUIREMENTS

- ✓(a) The regulations contain minimum requirements for the protection of workers in, and adjacent to, excavations against death and injury.
- ✓(b) Walkways, runways, and sidewalks shall be kept clear of excavated material or other obstructions and no sidewalks shall be undermined unless shored to carry a minimum live load of one hundred and twenty-five (25) pounds per square foot.
- ✓(c) If planks are used for raised walkways, runways, or sidewalks, they shall be laid parallel to the length of the walk and fastened together against displacement.
- ✓(d) Planks shall be uniform in thickness and all exposed ends shall be provided with beveled cleats to prevent tripping.
- ✓(e) Raised walkways, runways, and sidewalks shall be provided with plank steps on strong stringers. Ramps, used in lieu of steps, shall be provided with cleats to insure a safe walking surface.
- ✓(f) All Employees shall be protected with personal protective equipment for the protection of the head, eyes, respiratory organs, hands, feet, and other parts of the body as set forth in Subpart E of this part.
- ✓(g) Employees exposed to vehicular traffic shall be provided with and shall be instructed to wear warning vests marked with or made of reflectorized or high visibility material.
- ✓(h) Employees subjected to hazardous dusts, gases, fumes, mists, or atmospheres deficient in oxygen, shall be protected with approved respiratory protection as set forth in Subpart D of this part.
- ✓(i) No person shall be permitted under loads handled by power shovels, derricks, or hoists. Employees shall be required to stand away from any vehicle being loaded *by mechanized equipment on facility.*

- ✓(j) A competent person shall inspect the excavation for evidence of possible cave-ins or slides, and indications of structural failure in members of the shoring system. If evidence of possible cave-ins or slides or structural failures is apparent, all work in the excavation shall cease until necessary precautions have been taken to safeguard employees.

The competent person shall conduct an overall *thorough* inspection of the excavation and the ground adjacent to the excavation at least twice daily and shall conduct a special inspection after every rainstorm, penetration of water into the excavation, or other disturbance that could weaken the soil or the shoring system, and shall *direct the* increased protection against slides and cave-ins ~~where deficiencies are found~~ *where deficiencies are found.*

Dewatering operations and equipment shall be monitored by a competent person to insure their proper operation and precautions shall be taken to safeguard the workers in the excavation if dewatering equipment malfunctions.

#### 1926.651-SPECIFIC EXCAVATION REQUIREMENTS

- ✓(a) Prior to opening an excavation, efforts shall be made to determine whether underground installations; i.e., sewer, telephone, water, fuel, electric lines, etc., will be encountered, and if so, where such underground installations are located. When the excavation approaches the estimated location of such an installation, the exact location shall be determined and when it is uncovered, proper supports shall be provided for the existing installation. Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation.
- ✓(b) Trees, boulders, and other surface encumbrances, located so as to create a hazard to employees involved in excavation work or in the vicinity thereof at any time during operations, shall be removed or made safe before excavating is begun.
- ✓(c) (1) In excavations which employees may be required to enter, excavated or other material shall be effectively stored and retained at least 2 feet or more from the edge of the excavation.
- (2) As an alternative to the clearance prescribed in subparagraph (1) of this paragraph, the employer may use effective barriers or other effective retaining devices in lieu thereof in order to prevent excavated or other materials from falling into the excavation.

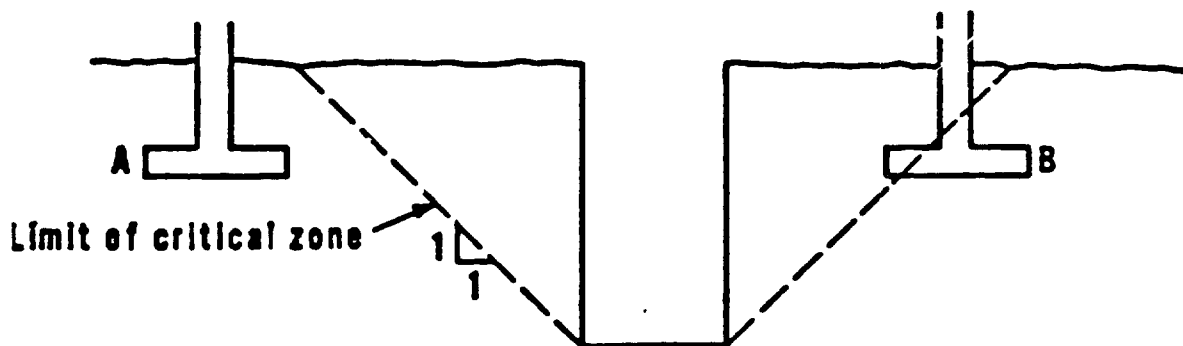
- ✓(d) Diversion ditches, dikes or other suitable means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Water shall not be allowed to accumulate in an excavation, unless this condition is considered in the design and in the initial work plan and adequate provisions are made to protect workers.
- (e) If it is necessary to place or operate power shovels, derricks, trucks, materials, or other heavy objects on a level above and near an excavation, the side of the excavation shall *be stabilized* ~~be shored~~ as necessary to resist the extra pressure due to such superimposed loads.
- ✓(f) Blasting and the use of explosives shall be performed in accordance with Subpart U of this part.
- ✓(g) When mobile equipment is utilized or allowed adjacent to excavations, substantial stop logs or barricades shall be installed. If possible, the grade should be away from the excavation.
- ✓(h) Adequate barrier physical protection shall be provided at all remotely located excavations. All wells, pits, shafts, etc., shall be barricaded or covered. Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc., shall be backfilled.
- (i) ~~If possible~~, dust conditions shall be kept to a minimum by the use of water, salt, calcium chloride, ~~oil~~, or other ~~means~~. *effective means*.
- ✓(j) In locations where oxygen deficiency or gaseous conditions are possible, air in the excavation shall be tested. Controls, as set forth ~~is in~~ Subparts D and E of this part, shall be established to assure acceptable atmospheric conditions. When flammable gases are present, adequate ventilation shall be provided or sources of ignition shall be eliminated. Attended emergency rescue equipment, such as breathing apparatus, a safety harness and line, basket stretcher, etc., shall be readily available where adverse atmospheric conditions may exist or develop in an excavation.
- ✓(k) Where employees or equipment are required or permitted to cross over excavations, walkways or bridges with standard guardrails shall be provided.

- ✓ (l) Where structural ramps are used for employees or equipment, they shall be designed and constructed by qualified persons in accordance with accepted engineering requirements.
- ✓ (m) All ladders used on excavation operations shall be in accordance with the requirements of Subpart L of this part.
- ✓ (n) Materials used for shoring, sheeting, and underpinning of structures adjacent to excavations shall not be damaged or weakened by corrosion, deterioration or prior use to an extent that will cause them to have a minimum strength less than that required in Section 1926.652(b)(4)(ii).
- ✓ (o) Employees entering bell-bottom pier holes shall be protected by the installation of a removable-type casing of sufficient strength to resist shifting of the surrounding earth. Such temporary protection shall be provided for the full depth of that part of each pier hole which is above the bell. A lifeline, suitable for instant rescue and securely fastened to a shoulder harness, shall be worn by each employee entering the shafts. This lifeline shall be individually manned and separate from any line used to remove materials excavated from the bell footing.
- A is best* ✓ (p) When employees are required to be in trenches 4 (5?) feet deep or more, an adequate means of exit, such as a ladder, steps or a negotiable slope shall be provided and located so as to require no more than 25 feet of lateral travel.
- ✓ (q) Shoring shall follow the excavation as closely as practical in order to avoid long sections of unshored excavation.
- ✓ (r) Members of the shoring system shall be installed in their proper position and secured to prevent failure.
- ✓ (s) Portable trench boxes or sliding trench shields may be used for the protection of personnel in lieu of a shoring system or sloping. Where such trench boxes or shields are used they shall be designed, constructed, and maintained in a manner which will provide protection equivalent to that provided by the shoring required for the excavation.
- ✓ (t) Backfilling and removal of trench support shall progress together from the bottom of the trench. Struts shall be released slowly and, in unstable soils, ropes shall be used to pull out the jacks or braces from above after employees have cleared the trench.

## 1926.652-SPECIFIC SHORING, SHIELDING AND SLOPING REQUIREMENTS

### (a) Acceptable Practice

- (1) The following excavations are exempt from shoring, shielding and sloping requirements:
  - ✓ a. Excavations less than 5 ft. deep, except when examination of the ground by a competent person indicates that hazardous ground movement may occur.
  - ✓ b. Excavations in unfractured rock.
- (2) Excavations from 5 ft. to 20 ft. ~~(24 ft. ?)~~ deep shall be shored, shielded or sloped in accordance with the Standard Practice in Section 1926.652(b) with the following exceptions;
  - ✓ a. If there is a deviation from the provisions of the Standard Practice, shoring, shielding or sloping requirements must be determined by an engineer (a qualified person ?) *or other experience qualified person.*
  - ✓ b. An engineer shall determine the shoring, shielding or sloping requirements whenever the bottom of a building foundation adjacent to the excavation which has not been secured by underpinning extends into the critical zone delineated in Figure 1.



- ✓ FOOTING A: Standard practice can be followed
- ✓ FOOTING B: An engineer shall be consulted

✓ Figure 1. Effects of Nearby Foundation Loads That Must be Determined by an Engineer

- (3) For all excavations deeper than 20 (24?) ft., except those in unfractured rock, an engineer (qualified person?) shall determine the shoring, shielding or sloping requirements, and assure its proper installation or use

(b) Standard Practice

✓(1) Scope

The Standard Practice provides a method by which field conditions are related to shoring, shielding and sloping requirement.

The Standard Practice makes a distinction between short-term and long-term excavations (see definition in 1926.653 - 24 hours (7 days?) is the division point).  
NO - Maybe 36-48 hours

✓(2) Soil Classification

Soils are divided into three types: A, B, and C. For each soil type the "equivalent weight effect",  $w_e$ , to be used for the calculation of lateral soil pressure on shoring systems, and the maximum permissible sideslope for sloped excavations are stipulated. Table 1 provides guidance for the selection of the soil type.

✓(3) Sloped Excavations

Sloped excavations shall not have sideslopes steeper than those stipulated in Table 1. If there is any indication of general or local instability, slopes shall be cut back to the stable slope. The slope configurations shown in Figure 2 can be used.

✓(4) Shored and Shielded Excavations

✓(i) Determination of Adjusted Depth

For the purpose of selecting shoring systems, trench shields, or trench boxes the depth of excavations shall be assumed greater than the actual depth in order to allow for spoil piles, construction equipment and sloping ground. This adjusted depth ( $H_a$ ) shall be determined as follows:

- ✓a. For ground sloping down from the supported or shielded excavation wall, level ground, or ground sloping up from the supported or shielded excavation wall with a slope less than 3 hor. in 1 vert. the Adjusted Depth ( $H_a$ ) is the actual depth of the supported excavation ( $H$ ) plus 2 ft. (surcharge allowance). (See Figure 3(a).)



- ✓b. Hydraulic shores or other pre-fabricated sub-assemblies or members of shoring systems shall be rated for allowable working loads and selected with the aid of the charts in the guidelines supplementing Subpart P, or selected directly from special charts prepared by the manufacturer.
- ✓c. Timber shoring shall be selected with the aid of charts in the guidelines supplementing Subpart P or from special charts prepared by an engineer (qualified person?).
- ✓d. Any other shoring system can be pre-designed and rated by an engineer (qualified person?) and selected on the basis of soil type and equivalent depth from charts prepared for this purpose.

✓(5) Special Provisions

✓(i) Intersecting Trenches

When two trenches intersect and one trench is shored, the intersecting trench shall also be shored from the intersection of the two trench walls to a distance of not less than its depth.

✓(ii) Sloping Ground

If the ground behind an excavation wall slopes up from the excavation wall and the ground slope exceeds 3 hor. in 1 vert. workers in the excavation must be protected against objects rolling or sliding from the sloped ground. This can be accomplished by projecting the sheeting at least 18 inches above the ground surface or by a specially constructed protective toeboard. If spaced sheeting is used provisions shall be made to close the gaps between projecting sheeting members. (Workers in excavations must be protected against rolling or sliding objects?)

✓(iii) Excavation Below the Bottom of Sheeting, Trench Shields, or Trench Boxes

Excavation up to <sup>6K</sup> 2 ft. (3 ft. ?) below the bottom of sheeting, trench shields or trench boxes is permitted in short-term excavations provided that:

- ✓a. No soil movement below the bottom of the sheeting, trench shield or trench box is evident; and
- ✓b. The forces acting on the bracing, trench shield, or trench box are calculated for the full depth of the excavation, and the lowest wales and struts are designed to resist the forces that would result if the sheeting would be projecting to the bottom of the excavation.

1926.653 DEFINITIONS APPLICABLE TO THIS SUBPART

- omit  
OK?*
- ✓(a) "Accepted engineering requirements (or practices)" Those requirements or practices which are compatible with standards required by a (registered architect) a registered professional engineer, or other duly licensed or recognized authority. Guidance for accepted engineering practices pertaining to excavation safety is provided in the guidelines supplementing Subpart P.
  - ✓(b) Acceptable Practice is a practice which meets the minimum requirements in Section 1926.652(a).
  - ✓(c) Adjusted Depth is the actual depth from the bottom of the excavation to the top of the supported excavation wall plus an additional depth to allow for surcharge, sloping ground, or heavy equipment as stipulated in Section 1926.652(b)(4)(i).
  - ✓(d) Allowable Working Stresses are allowable stresses determined in accordance with accepted engineering practices.
  - ✓(e) Belled Excavation is a part of a shaft or footing excavation, usually near the bottom and bell-shaped; i.e., an enlargement of the cross section above.
  - ✓(f) Clear Spacing of sheeting members is the distance between the edges of sheeting members over which the soil is unsupported (see Figure 4).
  - ✓(g) Competent Person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
  - 2  
0 (h) Engineer is a (registered) professional engineer.
  - ✓(i) Equivalent Weight Effects ( $w_e$ ) is the weight effect stipulated in Table 1 which is used to calculate pressures on shoring systems.
  - ✓(j) Excavation is any manmade cavity or depression in the earth's surface except as noted, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reasons of excavation. Excavations do not include tunnels and shafts, caissons and cofferdams covered by Subpart S of the Safety and Health Regulations for Construction.
  - ✓(k) Excavation Wall is the side of an excavation, rising from the bottom of the excavation to the ground surface.

- ✓(l) Fractured Rock is rock which could spall or crumble when excavated with vertical slopes. Fractured rock slopes secured against mass movement and spalling by rock bolts, netting, or other means approved by a qualified person are considered stable (equal to unfractured rock).
- ✓(m) Long-Term Excavations are excavations which are open for more than 24 hours (7 days?) 36-48 hours (Not 7 days)
- ✓(n) Mud Sills are wales which are installed at the level of the bottom of the excavation wall.
- ✓(o) Negotiable Slope is a slope on which a person can readily egress from or ingress to an excavation.
- ✓(p) Qualified Person means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.
- ✓(q) Safety Margin is any measure of excess strength over that required to resist the working loads.
- ✓(r) Sheeting is composed of members of the shoring system which are in direct contact with the soil in the supported bank.
- ✓(s) Shoring Systems are structural systems supporting the bank of an excavation.
- ✓(t) Short-Term Excavations are excavations which are open for 24 hours (7 days?) or less. 36-48 hours (Not 7 days)
- ✓(u) Sides, Walls, or Faces are the vertical or inclined earth surfaces formed as a result of excavation work.
- ✓(v) Slope is an incline expressed as a ratio of horizontal distance to vertical rise.
- ✓(w) Spaced Sheeting is sheeting in which the members bearing against the excavation wall are spaced (see Figure 6). Figure 4?
- ✓(x) Spalling is the continuous flaking and falling of soil or rock from an unsupported trench wall.
- ✓(y) Standard Practice is the trenching and shoring practice in Section 1926.652(b).
- ✓(z) Struts are the primary support members of a shoring system including but not limited to cross braces, raker braces, jacks and backties (see Figure 6) Figure 4?
- ✓(aa) Stable Slope is the slope which will remain stable for the duration of the excavation.

Raker braces or backties are not illustrated

- ✓(bb) Structural Ramp is a ramp built of material other than soil or rock.
- ✓(cc) Supported Wall is that part of an excavation wall which is supported by a shoring system or shielded by trench boxes or trench shields.
- ✓(dd) Trench Box see trench shield.
- ✓(ee) Trench Shield is a protective device which shields workers in a trench from the effect of mass movement of soil or rock and which can be moved along as work progresses.
- ✓(ff) Wales (walers) are members of the shoring system which are directly supported by struts and which in turn provide support to the sheeting (see Figure 4).
- ✓(gg) Working Loads are loads which should reasonably be anticipated to occur and which must be resisted with appropriate safety margins, determined in accordance with accepted engineering practice.

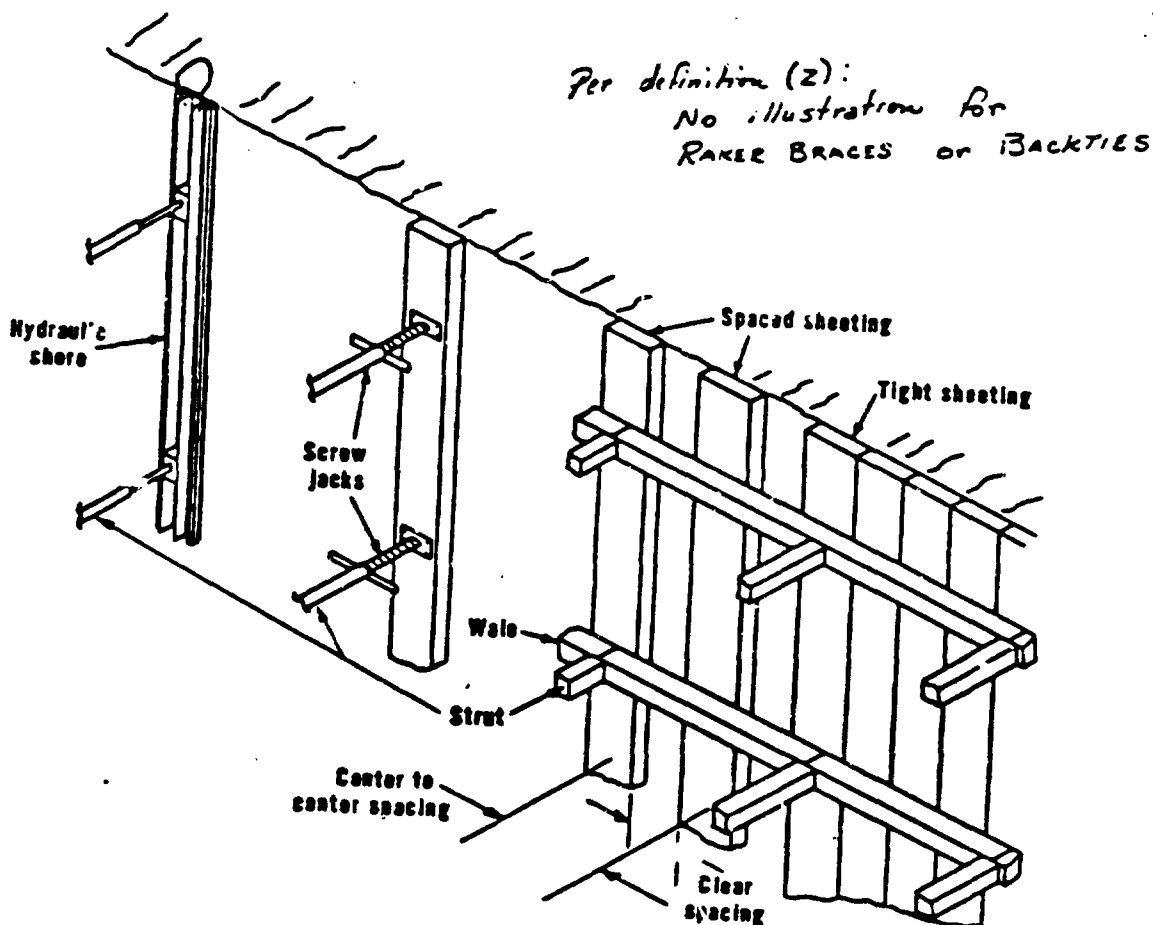


Figure 4. Components of the Shoring System

Minutes of Trenching and Shoring Workshop - Dallas

There were 41 persons in attendance at the AMFAC Hotel at Dallas/Ft. Worth Airport on June 30, 1981. Arthur L. Schmuhl, Director of Safety and Health Services for the Associated General Contractors, opened the workshop with an explanation of why the workshops were being held. He then turned it over to Bill Driskill, of the Texas Heavy, Municipal & Utilities Branch of A.G.C., who had agreed to serve as secretariat for the meeting. There were self-introductions and the representatives from the National Sponsors were introduced and asked for comments.

John Cook, representing the National Utility Contractors Association, made a statement that, "at this time NUCA is not taking a position on the working draft of Subpart P and will wait to see what the final draft is."

The next sponsor was Jack Mickle, representing the Building and Construction Trades Department of the AFL-CIO. Mr. Mickle provided a draft with the Building Trades recommendations on the revisions of Subpart P. He stated that the stand the Building Trades have taken is that whatever we wind up with has to be understandable by all. (Mr. Mickle's full text is attached to these minutes.) Mr. Mickle stated that his group had spent most of its' time looking at the first twenty pages of the proposed document, minus the first five pages. Based on this, he made the following recommendations: (1) Remove the misunderstandings such as the definition of stable slope. (2) Recommend the removal of Table P-2. (3) Include hydraulic shoring in standard practice with manufacturers certifications for use on the shore and shields be included in standard practice with manufacturers certification on the shield.

See attached document of Mr. Mickle's for all of their recommendations.

Mr. Sal M. Gosioglu, representing A.S.F.E., stated that his group has distributed the working draft to their members for comments and the comments will be forwarded to their A.S.F.E. representative, Mr. John Romage, for presentation at the Boston Workshop.

On conclusion of the statements by the sponsors, Dr. Yokel was called upon to explain what would be done with the products of the various workshops. He stated that the information from the workshops would be discussed with OSHA and NIOSH representatives and the regulations would be re-drafted. Dr. Yokel strongly recommended that the parties at the workshops should form a committee with the possibility of a meeting, or meetings, in Washington, D. C. with the idea of coming up with a consensus standard for submission to OSHA.

Dr. Yokel then gave a video presentation on the NBS study that was funded by OSHA. He stated that some 127 recommendations were made on arriving at the working draft by various groups such as labor, A.G.C., A.S.F.E., and other interested parties. Following Dr. Yokel's presentation on the various recommended changes in his working draft on Subpart P, and some of the comments on the proposals in previous workshops, the workshop was opened for comments.

John Cook, speaking for trench shield manufacturers, offered that it was their consensus view after they had reviewed in detail the working draft, that the attempt to clarify and simplify, as it relates to the revised changes in Subpart P, has failed and, in fact, has made it more confusing and more difficult to apply in the field and the proposed design criteria, as it relates to trench boxes, does not conform to accepted engineering practices and they have specific recommendations to be made later in the workshop.

The following comments were made after Mr. Cook's presentation:

(1) Del Talley, Executive Director, Austin A.G.C., raised the question as to why the American Society of Safety Engineers are not involved? It was Mr. Talley's feeling that A.S.S.E. should be involved in some manner since that organization represents the safety professionals in the United States.

Mr. Talley also asked about the adjusted depth chart and surcharge chart and what is the involvement of the American Society of Civil Engineers? Dr. Yokel then explained the charts again and stated the idea of the charts was to be simple enough so the man in the field could readily understand the standard. There was considerable discussion of the chart on page 14-Table 3 and the need to clarify this.

(2) Jerry Rosch, Brown & Root, Inc., Houston Texas, commented on the selection of competent people or qualified people and stated that OSHA has told them that the employer is to select that person and they (Brown & Root) go with the man with the most experience. Mr. Rosch requested that definitions be included that explain clearly what a competent person and qualified person is. Dr. Yokel stated that the definitions are in the documents but probably need more work to clarify them.

(3) John Collins, Kent Nowlin Construction Co., New Mexico, asked what happens with a six foot hole that is opened for eight days? Does it have to be designed by a qualified engineer? What is the definition of long term and short term?

(4) Walter Ruff, Ruff Construction Co., Dallas, Texas, commented and raised the question that long term and short term is predicated on a shoring system being involved. What if the contractor chose, instead of shoring, laid back or sloped to a safe angle, how would the long term and short term definition apply?

(5) Leroy Balser, Robert E. McKee, Dallas, Texas, stated that page 11 on Soil Classification for the Standard Practice is too arbitrary since soils vary from area to area.

Following these comments, Dr. Yokel went over the document step by step and asked for comments on item 1-7 page 3.

(1) John Cook, representing the trench box industry, commented on number 3 as to whether a qualified person should be substituted for an engineer. He felt the answer should be no, but that there are other areas in the working draft where a qualified person should apply but declined to say where. On number 4, he felt that more conservative requirements were not needed and short-term should be 7 days. On item 5, he stated that they felt the allowable slope in Table 1 is not in accordance with acceptable engineering practices and the stable slope concept should be used. On Item 7, their answer is yes it should be conveyed as part of definition.

(2) Phil Becker, Utilities Consolidated, San Antonio, Texas commented in regard to page 3 item 2, he felt that on exit requirements from a ditch, the exit requirements other than a ladder should be allowed such as shoring as a means or a negotiable slope allowed. On item 3 he feels that the 24 foot depth on the standard practice should be utilized and it is a common practice in his area for the industry. On Item 4, or short term and long term excavation, he feels that it is confusing building construction with utility construction and it is standard practice to leave areas such as manholes open a week or so. On Item 5, he felt stable slope should be the concept used. Item 6 - Leave it at two feet.

Item 9 - This needs to be determined at the time it is used but don't tie it down.

Item 11 - He is against having an engineer on the job, but use a qualified person. If you insist on an engineer, put it in the design and make it a bid item and everyone would bid on these items.



Mr. Becker stated that common sense must prevail in considering these proposals.

(3) Walter Ruff, Ruff Const Co., Dallas, Texas

Item 2 - 5' instead of 4'. Pipe should be recognized as a shield if large enough.

Item 3 - It should be extended to 24 feet and it is industry practice to work this deep. Job foreman should be recognized as a qualified person and an engineer should not be involved unless he include the shoring system at the design stage and be a bid item and OSHA write the law that the engineer's errors and omission will stand at the courthouse and let him be responsible for his design.

Item 4 - Short term definition should be deleted.

Item 6 - Leave it at two feet.

Item 9 - Should be a determination on each individual job.

Item 10 - Omit architect.

(4) Alan Hollingsworth, S. J. Groves & Sons.

Item 1 - This should not be dropped in that it causes problems on Highway projects.

Item 2 - Definition should be clear on negotiable slope.

Item 3 - Are we better off to leave this the way it is?

Item 4 - It is very controversial and many factors should be considered in order to establish a definition of "short term" or "long term" excavation.

Item 5 - Use the current regulations.

Item 6 - The current regulation is adequate. (2 feet)

Item 7 - What men in the field are we talking about? We recommend consideration be given to existing industry practice.

Item 8 - Bypass

Item 9 - No problem with this.

Item 10 - If we are going to have all these different people involved, let's name everybody since state laws, like in Illinois, can name every party and each named can be responsible for some portion.

Item 11 - No real problem, but tell us specifically what you want us to do.

Item 12 - 1926,650 gives us enough rationale to understand.

Item 13 - No significant problem with existing regulations.

The construction industry has not had good participation in this workshop paper and more across the country should be consulted.

(4) Phil Becker then referred those present to page 12 and page 15 and asked Dr. Yokel to explain open excavation without shoring and sloped excavation.

(5) Joe Kinnikin, AGC of New Mexico - Contractors in Texas and New Mexico are having a problem with 3/4 to 1 slope. We are dealing with undisturbed soils and not the molten soils like back east.

Dr. Yokel then asked for comments on page 5A. He stated that the two previous workshops had commented that these provisions should not apply when workmen are not exposed to mass movement of soil or rock. John Collins, of Kant Nowlin Const Co., asked the question about where employee exposure occurs and how far away from the face of an excavation does a workman have to be to not be exposed?

Alan Hollingsworth, of S. J. Grove, commented on page 7 that 651E & D appear to him to apply to borrow pits with water accumulating. He felt that a compliance officer who is not an engineer might make a judgment call that would cause more litigation. Dr. Yokel said this provision was carried over from the previous regulations.

Jerry Rosch, of Brown & Root, commented on section J. Emergency procedures in a confined space should be defined in J on page 7.

Walter Ruff, of Ruff Construction Co., commented on page 7 (e) and felt that this is impossible to meet. On (9) it should be deleted and item (k) it is not practiced on small ditch and should be deleted.

George Bradberry felt paragraph 1, page 8 should be dropped completely.

John Cook, representing trench boxes, stated item (5)<sup>6</sup> should read "as defined by accepted engineering practice" at the end of that statement. Also reverse the words "protection equivalent" to read "equivalent protection". This refers to pre-designed trench boxes.

Alan Hollingsworth, of S. J. Grove & Co., felt that specific trenching requirements should stay such and not be put in general excavation so the contractor can readily identify what he is supposed to do.

Phil Becker, of Utilities Consolidated, commented on page 8 on ladders and the length they must come above the trench and would reply in writing. On (p), it should be 5 instead of 4 and approximately 24' and not 25' specifically. On (q), he felt the section should be deleted. On (t), Mr. Becker recommended it be deleted.

Bill White, of the Houston Contractors Association, commented on page 7 (j), it should be deleted per prior meeting held by OSHA on this subject. Dr. Yokel asked Mr. White to submit specific recommendations after the workshop is over since it was not brought to his attention that the meetings were held when he made the study.

Jerry Rosch, of Brown & Root, remarked on page 8 (o) where you approach the situation on rescue, you are limiting yourself when you indicate shoulder harness without any, etc. following it because in situations there are times, and it has been proven, that harnesses, if a man wears shoulder harness or parachute harness or whatever, it is very difficult to get him out if you are on a vertical pull. I suggest you reword it this way, "adequate life-saving equipment suitable for instant rescue, shall be required of each employee entering the shaft. Employee personal protective equipment should include, but not limited to, harnesses, wristlets, or other acceptable devices. You need some leeway on this.

Jack Brown, Ruff Construction Company, commented on page 9 on acceptable practices on excavations less than 5' and on all charts still show the angle of repose from the bottom of a trench. If 652 C is to remain in the standards, you are contradicting it with these type photographs on the angle of repose. I would prefer to keep 652 C as it is rather than the proposed regs.

Phil Becker of Utilities Consolidated then commented on page 9 concerning the definition of unfractured rock should be clear in that if rock, if cracked, it doesn't mean that it is going to fall down. He continued by commenting on No. 2, page 9. He asked why limit excavations to be shored to 20 or 24 feet? He recommended that it read 5 feet and deeper or 5 feet and below shall be shored.

Mr. Becker recommended that a qualified person handle excavations below 24 feet. He stated that if Mr. Yokel is going to recommend that it is required, that anyone other than a qualified person on the project to excavate below 24 feet in depth, that he would like to see that Mr. Yokel require, in the Federal Register, that engineers design it in the project, in the plans, and have a bid item for that particular portion of that project. He reemphasized his point by saying that a qualified person can handle excavations below 24 feet and that if Mr. Yokel is going to recommend that it be an engineer's design, that Mr. Yokel recommend that it also be a sublimited design in the plans and have a bid item for it.

Continuing on page 9, no. 2, part B, Mr. Becker commented that should be in the plans and have a bid item for that area. If not, then that should be a qualified person that shall determine the shoring. He takes objection to the way it is written.

On page 10, Mr. Becker objects to No. 3 in regard to 20-24 feet. Wants engineer put in parenthesis and qualified person in capital letters. Number one under scope, page 10, would like to see short term and long term eliminated.

Walter Ruff, Ruff Construction Company - Eliminate the short term and long term and leave it up to the contractor. He commented that short term and long term takes away from the way a contractor can effectively operate his project and costs are going to escalate.

Del Tally, Austin AGC - Commented on page 10, No. 1, and said that it applies to building contractors also. Almost all building excavations are open more than seven days for basements, etc. Debate short term and long term.

John Collins, Kent Nowlin - Commented that we do not have the ground water in this area of the United States, as they do in the Northern states, so saddle us with something that applies to Wisconsin is unfair and vice versa.

Phil Becker, Utilities Consolidated - Page 11, objects to (5) rock and (c) long term excavation.

Joe Kinnikin, New Mexico AGC - Page 11, Type A, stated the need to recognize native soils and conditions. Need to define it better and reword it.

Del Tally, Austin AGC - Page 11, Chart - A, 3/4:1 should be returned to 4:1.

Phil Becker, Utilities Consolidated - Page 12, commented on the drawing. It is not always benched like it is shown and could be confusing to OSHA inspectors.

Del Tally, Austin AGC - Page 12, commented that three foot maximum for bottom bench needs to be discussed. Why couldn't it be 5 feet?

Walter Ruff, Ruff Construction - Added to the wording of that clause (page 12), that if it were required, by the size of the conduit, to be deeper than four feet, the fact that you would have the safety factor there that a worker could get into the conduit in case of a collapse that you could take exception to the rule above four feet if the conduit so required for proper embedment. The pipe is strong enough to hold all of the dead (load, weight) of backfill, it will be a safe haven to a laborer in case of collapse, to crawl into it even if it were up to five feet.

Del Tally, Austin AGC - Asked why five feet would not be acceptable there (page 12)? Commented that it is confusing to field people in having different footages. Like requiring a ladder at four feet, shoring at five feet, why not say at five feet you need to do this? Just have one depth.

Alan Hollingsworth, S. J. Groves & Son - Commented on page 12. Industry is concerned about specifications from a contract owner that says he will place pipe in a specific type of performance activity. And then you indicate that we will shore; slope in accordance to given OSHA standard criteria. Hollingsworth said it seems to be a "Catch 22" situation for the contractors. Since OSHA regulations are not applicable to any governmental agencies, that puts the contractor in a situation where we have to conform, but the people writing the plans and specs do not. That makes the contractor put a price on a job that is not stipulated for him to do so. Contractors could do a better job if government agencies had to conform to the regulations and then there would not be an absence of this information available to the contractors.

Joe Kinnikin, New Mexico AGC - Page 11 and 12, depth of trench, commented that this will make the contractor shore in cities because of right-of-way requirements.

Del Tally, Austin AGC - Page 15, what is the alternative to drawing (c) showing heavy equipment? Usually you do not operate under the regime.

George Bradberry, Shoring Service, Page 15 (in diagrams A & C) recommended to shave off shoring extending above the top of the trench because it usually serves as no purpose.

Phil Becker, Utilities Consolidated. Page 16 (D) - Eliminate engineer. Commented that there could be several other shoring systems that would not have to be pre-designed by an engineer. Objects to the words "any other shoring systems".

Del Tally - Austin AGC - Page 16 (iii) - Take out the words "short term excavation". Second paragraph of (iii), two feet should be three feet.

Jack Mickel - Building and Construction Trades - Commented on the qualified person/engineer discussion. He stated that these standards are going to be used by everybody. The contractors at this meeting have qualified people, but there are other small contractors who do not and they will wind up killing people. That is why the term engineer is used. He raised the question of how do you define or determine a qualified person?

Alan Hollingsworth - S.J. Groves & Son - Added to the comments of Mr. Mickel. We cannot regulate morality. To add additional regulations to make others who do not comply with these rules is not going to achieve the goal. Mr. Hollingsworth also had a comment on Page 16 (iii). He was concerned about the wording "no soil movement".

Johnny Hall - SACC, Inc. - A piece of paper does not qualify anyone to do anything. The qualified person is the guy who is going to have to wind up doing it in the end. Recommend that licensing be left out completely.

Alan Hollingsworth, S. J. Groves & Sons, Page 18(A) last sentence. Asked the question if the last sentence in (A) is still a part of the definition? He does not want supplemental guidelines given to OSHA and not given to the contractor. Recommended having everything that's meaningful in the standards and not have any back-door guidelines that is not available to the industry, so we will know what to conform to and no one else will have a different viewpoint. He added that we do not want to overlook product liability.

Del Tally, Austin AGC - Page 18(H) - Need to leave out the word registered because some engineers are not registered engineers. Page 19(C) - Fractured Rock - commented that if it is not falling, it must be all right. Added that bolts and netting to prevent massive movement of the rock is pretty tough,

and doesn't know how that is going to work. Said that items (M) & (T) should be removed.

Bobby Margroder - Du-Mor Enterprises - Believes that (L) on page 19 should read, fractured rock - rock which could spall or crumble when excavated with vertical slopes. Fractured slopes secured against mass movement and spalling. Recommends that competent person needs to be put in place of qualified person.

In reaching page 20 of the Working Draft of suggested revisions, Dr. Yokel stated that the other workshops did not cover anything other than the material up to page 20. He then asked for general comments from the audience.

Jack Brown - Ruff Construction Company - Asked if this is drafted up and we use all these technical people, engineers, and formulas, then when it is put into effect, are we still going to get these four week "wonder" compliance officers to come out and check all of this technical stuff?

Alan Hollingsworth - S. J. Groves & Son - Mr. Hollingsworth had these final comments. He started out by saying he was concerned with the reason why OSHA wanted to review and revamp sub-part P. It is his opinion that it is not for employee safety, but for looking at shoring and sloping characteristics. Unless there is statistical data that says the present standard has not worked and it is causing a significant amount of injuries and fatalities, then why are we revising something that we don't know why we are revising? He brought out the point that he knew of several instances where governmental agencies were performing these trenching and excavating requirements and there were fatalities and not even an OSHA compliance review was held because they are exempt from these regulations. He asked if the statistics available reflect the real picture of the people who must conform to OSHA regulations. Mr. Hollingsworth stressed that he did not



want to let factors become requirements unless they are based on sound findings.

Mr. Hollingsworth continued his comments by saying he fully understands that a lot of contractors have not conformed to the requirements of the standards and therefore the industry has suffered. But sub-part P of the regulations has sustained a high degree of success in achieving the goal in the field of trenching and shoring. The industry has had 11 years of use of the OSHA regulations and has thus improved the safety factors to establish an acceptable set of industry practices. If new proposed standards are accepted, we will again start the litigation process to establish a new set of legal precedence. Mr. Hollingsworth commented that in light of the economic impact of the construction industry and the government, we cannot afford another 11 years to establish new legal precedence only because we want to replace the industry expertise with more educational certificates.

Another concern of Mr. Hollingsworth is it appears whenever there are factors outside the proposed standard practices, present work must cease until a registered engineer can establish the certified criteria and procedures to insure safety factors for all interested parties. Employees will be sent home without pay and can affect additional crews that will also be sent home. Unless the contractor has a registered engineer on his payroll, which many do not, he must seek to find one to take the responsibility to establish the new procedure as established by the regulations. The amount of delay this will cause is an unknown factor, but it can only cause costs to soar and have the loss of valuable work time. A registered engineer cannot insure the safety implied by the proposed regulations.

Mr. Hollingsworth then had a few critical questions he asked. What statistics are available to show that the current regulations have done to escalate the cause of injuries or fatalities? If changes are warranted,

has a cost benefit analysis been made to allow for a better understanding of the regulatory impact?

In summation, Mr. Hollingsworth said that if the short set of regulations has not created significant problems for management and the safety of their employees, then let's not consider efforts to reinvent the wheel and redundancy.

After those comments, Dr. Yokel made a short statement and turned the meeting over to Bill Driskill. There being no further questions or comments, the meeting was adjourned.

### 3. RESPONSES BY F. Y. YOKEL TO MISCELLANEOUS WORKSHOP CORRESPONDENCE

The letters in this section were written in response to some of the written comments submitted in the workshops. Many more comments were made, such as written comments submitted by AFL-CIO; however, there was no follow-up correspondence. Many of the comments are discussed in the workshop summaries in Section 2.



UNITED STATES DEPARTMENT OF COMMERCE  
National Bureau of Standards  
Washington, D.C. 20234

July 16, 1961

Mr. John B. Cook  
Efficiency Production, Inc.  
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Lansing, Michigan 48909

Mr. Wendell Wood  
Griswold Machine & Engineering  
Highway M-60  
Union City, Michigan 49094

Gentlemen:

First I want to express my regret that we did not communicate sooner. Had you been involved in the preparation of the Workshop input draft, we would probably be much closer now to a meeting of the minds.

Before going into details, I would like to make some general comments:

1. The "Standard Practice" is proposed because we came to the conclusion that it is in many cases not practical to have an engineer design the shoring in a trenching situation. This reflects the real-life situation, and ASFE is in full agreement with this conclusion. The "Standard Practice" in no way precludes that decisions on shoring be made by an engineer. If an engineer does make the decisions, he does not have to follow the Standard Practice [1926.652(a)(2)].
2. The "adjusted depth" in the Standard Practice is designed to enable the foreman to allow for surcharge situations. While it is true that a spoil pile is higher than 2 ft., it is very unlikely to cause lateral loads greater than those caused by an evenly distributed surcharge of 2 ft. in the typical trenching situation. If we eliminate this adjustment, an engineer would have to be consulted in every instance. We do not believe that this is realistic.
3. The introduction of the concept of the short-term excavations again reflects a real-life situation. It is a fact that in actual construction practice in the U.S. and other countries, slopes are steeper and shoring systems are weaker than those that would be recommended in accordance with accepted engineering practice. However, there is no reason to reduce conventional safety margins for excavations which stay open for many months.
4. To come back to "accepted engineering practice": Coulomb and Rankine did their work a long time ago, at a time when actual measurements were not available. Appendix A reflects present engineering practice which is based on measurements which were made in the last 20 years, some of them as recently as 2 years ago. Now it is true that nobody made measurements for the trench box situation. I expressed my preliminary thoughts on this in the memorandum on the Dallas Workshop

(attached). I think you have a point when you draw a distinction between trench boxes and typical shoring. However, you made a good case for sands, but not for clays. Sands will develop the typical "active" pressure diagram when enough displacement is allowed. However, clays will creep, and when bearing against a retaining structure which is restrained about equally top and bottom (as distinct from a retaining wall which can rotate about its base) will exert some sort of parabolic pressure diagrams which is closer to the square than the triangular. Once we deviate from the simple lateral-load requirements of the proposed soil classification, one would have to make a case for the extreme in each category. This would be medium clay at the lower strength limit for Type B soils and soft clay in an excavation with a soft bottom for Type C soils. I am not really opposed to somehow permit an engineer to make the case for the full range of soils falling under Type B and Type C soils, as an alternative to using the proposed pressure diagrams. However, I suspect that if you do that your gain in material will be trivial (and perhaps you will lose).

If you believe that an engineering alternative to the standard pressure diagrams is desirable, I would urge you to propose a specific amendment to Section 1926.652(4)(ii).

Here are some specific comments on your submission:

1. I suggest that you date future submissions, since you may change your mind on some points and we must be sure we always reference the proper memorandum.
2. Page 8, item(s) - I do not object to this.
3. Page 9, item 2a - Who will determine which engineer is "qualified?"
4. Page 10, item (b)(1) - My own inclination is to make the dividing line 3 days. This will allow leaving trenches over a weekend without extra struts. You may choose not to distinguish between long- and short-term for trench boxes.
5. Page 10, item (4)(i) - An engineer, if he gets involved, would probably not use the tables.
6. Page 11 - 30 lb./ft.<sup>3</sup> for Type B soil would be in my opinion grossly inadequate for medium clays. Even 40 lb./ft.<sup>3</sup> is on the low side.
7. Page 13, item (ii)a - If an engineer wants to make a case that a trench box is adequate for a certain depth and soil type he could go to the state-of-the-art and use the appropriate pressure diagram. Otherwise your proposed modification could produce inadequate design. I would welcome any specific suggestions for simplifications in Table 1. We have been trying to do that for a long time.
8. Page 13 (ii)c - See Dallas memorandum.
9. Page 13 (iii) paragraph 2 - I doubt that a foreman in the field could use engineering practice to select shoring.

10. Page 13 (iii)a - Would you make a surcharge allowance in your advanced rating? Otherwise surcharge is likely to be ignored altogether.
11. Page 16, item 4 (iii)(4) - You are probably right.
12. Page 16, item 5 (iii) - There seems to be a consensus on your suggestion. However it has been suggested that item (a) may be too vague as we wrote it.

Definitions:

13. 18 a - I agree with you.
14. 18 c - See previous comments.
15. 19 m - See previous comments.
16. 19 o - Your definition is a step in the right direction, but may still be too vague.
17. 19 t - See previous comments.
18. 19 z - I agree.
19. 22 - 2.1 - If we eliminate B(c) there would be the question what is accepted engineering practice for, say, the oil pressure in hydraulic systems? However, certainly I have no problem with following engineering practices to the extent that they are defined.
20. 22 - 2.1 A and B - This should be further discussed.
21. 22 - 2.23 - See previous comments.
22. 27 - 2.32 - How are we going to reasonably control the quality?
23. 30 - Appendix A is at best a guideline. It does, however, agree with present practice in excavation bracing (see reference listed).
24. 37 - 5(b) - Should be further discussed.
25. 38 - A.5.2 - Few practicing geotechnical engineers would agree - however a special case for the trench box, if thoroughly documented, could conceivably be appropriate. Perhaps Wayne Clough's (Stanford University) programs could be used to make a study. Unfortunately the NBS funding situation would not permit me to undertake such a study.

I appreciate very much your effort to contribute to an improvement in our draft standard. I would suggest that we try to have a dialogue with ASFE on some of your suggestions.

Sincerely,

Felix Y. Yokel, Leader  
Geotechnical Engineering Group  
Structures and Materials Division  
Center for Building Technology, NEL

cc: Mr. Paul Bouley  
Mr. John Maragliano  
Mr. John Ramage  
Mr. Ronald Stanevich  
Mr. Bill Zoine



UNITED STATES DEPARTMENT OF COMMERCE  
National Bureau of Standards  
Washington, D.C. 20234

August 13, 1981

Mr. Gordon Helmeid  
Director, Bureau of Technical Services  
State of Wisconsin/Department of  
Industry, Labor and Human Relations  
201 E. Washington Avenue  
P.O. Box 7969  
Madison, Wisconsin 53707

Dear Mr. Helmeid:

I was gratified with your supportive comments on our proposed standard practice for excavations and I would like to discuss some of your specific comments.

1. You take exception to the suggestion in my Workshop memorandum that no changes should be permitted when a traditional practice is accepted on the basis of its track record. I think that my statement was somewhat vague and you therefore misread the intent. What I suggest to stay away from is taking some traditional scheme - say timber, and then substituting some of its members by other members of "equivalent" strength, say aluminum. There is much danger in this. A wood member may have a safety factor of 4 relative to its actual failure strength, while the aluminum member has only a safety factor of 1.6 or even less. There is also the problem that lateral loads on bracing members depend on their stiffness and method of installation. Consequently, I propose that if any substitution is made, the new member should comply with the standard practice. I certainly would be the last person to suggest that safety rules should not be upgraded. However, what I strongly suggest is that the standard practice be followed when the upgrading is implemented. This way we will eventually move toward uniform practices in the U.S. which will be beneficial for safety as well as economy of the work.

2. I am not sure what you refer to in the fourth paragraph of the second page of your letter. I thought you may be talking about comment 1, page 3 of the "Working Draft." This comment should read: Section 1926.651(o).

3. I take it that you recommend a 20 ft. depth limit. As you probably know this has been a point of controversy in the Workshops. Contrstors in most parts of the Country (except California) favor 24 ft., Unions favor 15 ft. You come down

in the middle. I think I could live with 24 ft. if we have some safeguards for soft soils.

4. Qualified Person - Please note that we have two definitions: a "competent person" is one who is competent to implement the standard practice in the field. A "qualified person" is one who can design shoring using engineering principles.

You may note that in our draft we refer to an "engineer" rather than a "qualified person." However, many contractors, particularly in the South (Dallas and Atlanta Workshops) favor the definition of "qualified person."

5. The reason for recommending deletion of Table P-2 is that we could not prove that the timber sizes are consistent with good engineering practice, and there was also no evidence (like in the case of the Wisconsin regulations) that the table is used in practice. We are not against providing tables for timber, hydraulic shores and possibly other systems in an appropriate Appendix. But I see no point in singling out one material for such a presentation.

6. The timber table in the Appendix of the Workshop paper was developed using the Standard Practice. Allowable timber stresses used were for Mixed Hardwood II which includes some weak wood species (see Page 29). Unfortunately, engineering calculations do not support the common field practice of using the same timber sizes for struts and wales. Note that the table goes to very wide horizontal spacing of struts and uses a 5 ft. vertical spacing (except for spot bracing). Generally, strut sizes come out to be consistent with traditional field practice. Wales sizes in our table are larger than those commonly used (in spite of the 20 percent load reduction we permit for wales). There is nothing to prevent a contractor or a region or State from developing their own timber tables, using the design loads and stresses stipulated in the Standard Practice.

7. The wood table was developed in our timber study, precisely for the reason that hardwood is not graded, and is based on an extensive field survey. It is quite possible that the hardwood timber supplied in Wisconsin qualifies for Mixed Hardwood I, or even Mixed Oak. The Forest Products Laboratory in Madison could probably make this determination. Note that we recommended in our timber report (BSS 122) that the Industry adopt grading for trenching timber. If this were accomplished, we could probably go to higher design stresses.



8. Soil Classification - Unfortunately there are many soil types, and any way you want to group them you have some problems. We felt that the most important "common denominator" for grouping soil is pressure exerted on shoring systems. We also came to the conclusion that it is impractical to have more than three soil types. Thus under Type C we have all soils which are likely to develop high lateral pressures. These include soft clays, which can stand on relatively steep slopes, but also very weak soils such as marine silts which cannot be sloped at all. Thus the slopes we stipulate are the "steepest allowable," but not necessarily the "steepest possible." I am trying to introduce the "stable slope" concept, which would put more responsibility on the contractor in choosing the slope, but it is opposed by AFL-CIO. Note that on Page 11, footnote 3, we say that soft soils include clays which can be easily penetrated several inches by the thumb and soils that cannot stand on a 3:1 slope (muck). This is a reference to two entirely different soil types. The soft clay will easily stand on a 1-1/2:1 slope. The muck probably cannot be sloped at all. Both, however, exert high lateral pressures on shoring. By the way, I had no problem correlating our soil classification with yours, and I believe that our classification could work well in Wisconsin.

9. Gravity Load on Struts - The 240 lb. load on struts was stipulated so that, in an emergency, the strut could support a man who is trying to climb on it. We found ample evidence that workers do step on struts, regardless of what we stipulate in our regulations. This is also the reason why AFL-CIO would want an even larger gravity-load resistance. I am quite aware that the 2 in. thick Wisconsin struts cannot support such a gravity load.

I do not know if this letter answers all your questions. I would very much welcome the opportunity of working with you in an attempt of reconciling your needs with the proposed Federal Standard. I am trying to get some further funding from OSHA or NIOSH so NBS can stay involved in this problem until everything is resolved and I hope that these agencies will recognize the importance of a successful "end run."

Sincerely,

Felix T. Yokel, Ph.D., P.E.  
Leader, Geotechnical Engineering Group  
Structures and Materials Division  
Center for Building Technology, NBS

Enclosures

August 12, 1981

Mr. A. Youhanaia  
Bridge Engineer  
Chicago, Milwaukee, St. Paul  
and Pacific Railroad Company  
316 West Jackson Boulevard  
Chicago, Illinois 60606

Dear Mr. Youhanaia:

This is in response to your July 21, 1981 letter. I shall try to answer your questions.

(1) Surcharge:

Surcharge effects were derived by elastic theory based on the assumption that the surcharge load is applied after the bracing is in place. Since 1 ft. of additional depth in Type A soil will produce a lateral thrust of 20 psf, and 1 ft. of Type C soil will produce a thrust of 80 psf, the depth adjustment for Type A soil has to be greater. (See derivation on Page 44 of the enclosed report.)

(2) Effect of Adjacent Foundations:

The rule of thumb that is proposed to identify cases where adjacent foundations significantly affect the lateral forces on bracing is presently widely used and is generally conservative. However we recognize that there may be instances where it is not conservative enough.

You should keep in mind that the standard practice proposed in the article is intended to insure the safety of workmen. Other important aspects of excavation practice, such as settlement control of adjacent structures are not within the scope of OSHA jurisdiction.

Sincerely,

Felix Y. Yokel, Leader  
Geotechnical Engineering Group  
Structures and Materials Division  
Center for Building Technology, NREL

Enclosure



**Chicago, Milwaukee, St. Paul  
and Pacific Railroad Company**

516 West Jackson Boulevard  
Chicago, Illinois 60606  
Phone 312/648-3000

July 21, 1981

Geotechnical Engineering Group  
Center For Building Technology  
National Engineering Laboratory  
National Bureau of Standards  
Washington, D.C. 20234

Gentlemen:

This refers to the article "New Concepts For Construction Practice Standards For Excavations," by Messrs. Felix Y. Yokel and Riley M. Chung of the National Engineering Laboratory, National Bureau of Standards and Mr. Ronald L. Stanevich of the National Institute for Occupational Safety and Health, as printed in the April, 1981 issue of "Concrete Pipe News" of the American Concrete Pipe Association.

Specifically the reference is to the table for additional surcharge allowance for heavy equipment near supported excavations.

For a given trench depth and weight of equipment the additional surcharge depth is indicated as greatest for soil Type A and least for soil Type C.

In the soil type table Type A soil exerts the least equivalent weight effect and Type C soil exerts the greatest effect.

Type A soil is indicated as having greater cohesion while Type C soil possibly could have a coefficient of active earth pressure equal to or greater than Type A depending on their friction angles  $\phi$ .

Can you explain the rationale in which Type A soil exerts greater force from heavy equipment and consequently requires greater additional surcharge than Type C soil?

The second question is in reference to the effects of nearby foundations on supports for excavations. Our interpretation of the data for this topic is that any foundation beyond the limits of a 1 to 1 slope line from bottom of excavation will not produce force on the excavation supports. Are we correct in this interpretation?

Any additional information you can supply would be greatly appreciated.

Yours truly,

A. YOUNANAIE  
Bridge Engineer

RJW:jmb

4. MILWAUKEE, WISCONSIN, WORKSHOP - WRITTEN COMMENTS AND CORRESPONDENCE

This section contains all the written comments and correspondence associated with the Milwaukee, WI workshop.



State of Wisconsin \ Department of Industry, Labor and Human Relations

SAFETY & BUILDINGS DIVISION

201 E. Washington Avenue  
P.O. Box 7989  
Madison, Wisconsin 53707

July 9, 1981

Dr. Felix Y. Yokel  
United States Dept. of Commerce  
National Bureau of Standards  
Bldg. 226, Room B-162  
Washington, D.C. 20234

Dear Mr. Yokel:

The Trenching Code ad hoc Group of Wisconsin DILHR generally agrees with the spirit of the revisionary work being undertaken by you and your select committee on the basis that it inspires and provides for a necessary review of the Wisconsin trenching safety rules. The Wisconsin Trenching Code has historically provided the State with a good safety experience in this construction activity.

Comment to the effect that a good 'track record' is recognized and given consideration in the revision being contemplated is noted in your memorandum of June 23, 1981. That the State of Wisconsin, which has had a trenching code since 1/2/56 (revised 1/1/63), is singled out, is viewed as both complimentary and supportive of the past work done in trenching safety in the State of Wisconsin.

We should like to comment more directly on the items contained in your memo of June 23 and also provide suggestions and what we feel are constructive comments relating to the WORKING DRAFT<sup>17</sup>.

Reference is made to Page 1 of your memo wherein you quote from a summary recommendation made in (BSS 127), Appendix A: Page 59, A.3, first paragraph:

Traditional timber shoring practice varies widely from location to location and frequently depends on such variables as sizes and characteristics of available timber, soil conditions, and local work practices. In some locations these practices have been used for many years and appear to be satisfactory to all the parties concerned. Three such locations are the State of Wisconsin. . .

In the same document, Page 65, second paragraph:

Since, in spite of the results of this analysis, NCS could find no evidence that conventional timber practice, if properly executed is unsafe, consideration could perhaps be given to temporarily exempting conventional timber shoring from the lateral load requirements until lateral load effects can be further studied by actual measurements in the field.

Mr. Felix Y. Yokel  
Page 2  
July 9, 1981

The foregoing commentary has an affirmative and positive air, and it is hoped that this attitude toward rules of long standing will not be changed by the obvious trenching rules. A statement made (Dr. Yokel memorandum, Page 2):

(b) The evidence on which we can base the permission to use a traditional practice which does not comply with our recommended provisions is its track record, rather than compliance with engineering principles. Thus, if it is allowed, no changes in it should be permitted. Such changes would include substitution of any of its members by other members of "equivalent" strength.

It can be stated here that the rules used in the State of Wisconsin were not developed in an arbitrary and capricious manner, but were developed consistent with engineering principles and practices in vogue at conception of the rule. The exceptional track record came about because of the rule, not in spite of the rule. Further, the statement no changes in it (rule, practice) should be permitted, tends to prevent upgrading a rule should it be desirable to do so in the interests of maintaining the good track record established. It would seem more reasonable to permit change of rule to upgrade the Code based on approval by some jurisdictional body. However, the precaution to permit only practices which are actually widely used and discard other parts which do not have a proven track record, is certainly acceptable.

In the WORKING DRAFT<sup>1/</sup>, the proposed Subpart, (p), 1926.650 General Protection Requirements, which appears on Page 5, is generally acceptable to our ad hoc Group. However, in 1926.651 Specific Excavation Requirements, the Subpart I referred to you under 1926.651 appears to be omitted.

In the WORKING DRAFT<sup>1/</sup> tables and charts are based on a depth of 20 feet maximum depth of excavation. It is understood that the question of depth consistent with "Standard Practice", has not been resolved at this writing. It is hereby suggested that a depth of 20 feet be established and charts be prepared to reflect this concept. The IND 6.2<sup>2/</sup> may be adjusted to reflect the 20 feet depth concept.

In Part 1926.653, WORKING DRAFT<sup>1/</sup>, Definitions Applicable to this Subpart, (p), Page 19, a definition is provided for a Qualified Person. It is hereby suggested that the definition, as presented, covers persons in a supervisory capacity within the scope of Standard Practice. Where conditions of trenching are met which are beyond the scope of Standard Practice, i.e., trenches of depth greater than 20 feet, design of ground support must be provided by a Registered Professional Engineer. This will bring about a dual category of Qualified Person; a category for the person where the trench is greater than 20 feet in depth.

The reason given for deletion of Table P-2, Page 57, of the WORKING DRAFT<sup>1/</sup> is that "Timber is not the only material used. Revised timber tables are in the Guidelines, Appendix B." This statement is confusing. Is deletion due to the fact that no "equivalence" is tolerated (in new rules)?

Dr. Felix Y. Yokel  
Page 3  
July 9, 1981

Descriptive terminology, it is felt, should be examined for clarity particularly in the use of such terms as "Safety Index," "Factor of Safety," "Compliance Measure," etc.

The WORKING DRAFT<sup>1/</sup> lists twelve (12) timber sizes to be used to fabricate required shoring (see Tables B1, B2, B3 and B4). Few occasions will arise where the trenching contractor will use all the listed sizes for a particular trench project, but the various sizes must be available for use by the contractor in order to comply with the formulated rules. IND 6.2<sup>7</sup> on the other hand, lists six (6) timber sizes.

On Page 29 of the WORKING DRAFT<sup>1/</sup>, Table 51, refers to allowable stress in wood members. It is the feeling of this ad hoc Group that the Table is too refined when it is considered that in the State of Wisconsin wood shoring members are composed of wood which is not 'graded' with the exception of a critical visual examination at the time it is placed. The wood can be described as mixed hardwood, rough-sawn, and not formally graded.

In the WORKING DRAFT<sup>1/</sup>, Page 11, Table 1, Soil Classification System for the Stand and Practice, an inconsistency presents itself. Soil Type C, Saturated, Submerged or Softway, at a trench depth of 12 feet or less, have a "steepest allowable slope hor.:ver. of 1-1/2:1." Our attention is then directed to a qualifying footnote for Soil Type C which describes this soil as "... soils that cannot stand on a slope of 3 hor.:1 ver. without slumping (muck)." It appears that we have here two definitions for Soil Type C. The ad hoc Group attempted a correlation between "soft" soil Table 1; and Table A.3, Page 42, in the WORKING DRAFT<sup>1/</sup>. It is our feeling that soil classifications as presented in IND 6.2<sup>7</sup> are more appropriate for use in the State of Wisconsin.

On Page 3, second paragraph of Dr. Yokel June 9, 1981, memorandum, reference is made to a 240 lb. gravity load placed at the center of trenching structures. The Wisconsin Trenching Code ad hoc Group is not familiar with the 240 lb. design requirement and would appreciate an explanation or the rationale. We have also noted that the AFL-CIO discussion prepared by Jack Mickle recommends a 500 lb. gravity load.

In summary, the good track record for trenching activity in Wisconsin has been a source of pride to this department and affirms our contention that the shoring and proposed requirements of IND 6.2<sup>7</sup> are adequate for ground conditions found in Wisconsin. These items, which we feel will enhance our IND 6.2<sup>7</sup>, have been set forth in this letter to you.

Since we are supportive of your work, and conscious of our own unique position in the matter of safety and trenching in Wisconsin, we will recommend all communications from you and your select committee.

Dr. Felix Y. Yokel  
Page 4  
July 9, 1981

Should the occasion arise for you to do so, please feel free to use or adapt in any way parts of IND 6.2<sup>1/</sup>. Should you have any questions concerning this document (IND 6.2<sup>1/</sup>), or find that we can be of assistance to you or your committee, please call us at (608) 266-1818.

Sincerely,

  
Gordon Helmeid, Director  
Bureau of Technical Services

GH:lmb

cc: John Wenning  
John Drake  
John Ramage  
Pete Gronbeck

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<sup>1/</sup>WORKING DRAFT OF SUGGESTED REVISION OF SUB-PART, (p), OF THE SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION BASED ON BUILDING SCIENCE SERIES REPORTS BSS 127, by Dr. Felix Y. Yokel.

<sup>2/</sup>WISCONSIN ADMINISTRATIVE CODE SECTION IND 6, TRENCH, EXCAVATION AND TUNNEL CONSTRUCTION.



**METROPOLITAN ST. LOUIS SEWER DISTRICT**



**July 13, 1981**

**National Bureau of Standards  
U.S. Department of Commerce  
Washington, D.C.**

**Ref: OSHA, Sub-Part "P", Suggested Revision**

**Gentlemen:**

We have reviewed the working draft of the Sub-Part "P" revision as issued on February 20, 1981. As an agency charged with responsibilities for storm and sanitary sewerage in a metropolitan area with an old-core city, safety of personnel especially during maintenance is of primary importance. Of almost equal importance, however, is a continual lack of sufficient funding to do the quality job that we would like to do. Accordingly, our interest in this regulation is that its provisions be appropriate requirements for safety of personnel and also, that these requirements be not excessively demanding and therefore, not justifiably costly.

We feel that the draft, as presented with the basic Sub-Part "P" being supplemented by rather than including guidelines, is proper format for the regulation.

We regret that the original topic heading "Excavations, Trenching and Shoring" has been changed to "Excavations and Shoring" because the great majority of the site conditions in which we are involved, are trenching situations.

For trenching applications, as compared with excavations for building and other large area construction, with the difference in time span between starting excavation and backfilling, the more rapid trenching techniques used by the construction trades are successful because materials in which excavations are made, may have different physical properties over a short span of time of up to several days than when excavations are held open for months.

While much of our new construction is by contract with the private sector, with plans and specifications usually prepared by outside consultants working to our design guidelines, the

majority of maintenance work is done by our specially trained and equipped crews.

Many of our maintenance operations are in areas where previous construction has resulted in situations with subsurface conditions markedly different from a virgin site. Because of this, we feel that experience of alert construction personnel is at least as important as formal academic training. We strongly suggest that the abilities of the "competent person" or "qualified person", as defined in 1926.653, paragraphs (g) and (p), be used to indicate a more reliable and suitable responsible person than the definition in (h) of an "engineer" as a registered professional engineer. The intent of Sub-Part "P" of OSHA is to establish minimum requirements for safety of personnel working beneath the ground surface. Our operations are with experienced foremen working with stable, experienced crews. Most of these foremen, as well as members of their crews, have the abilities of "qualified persons" and the foremen have the authority of a "competent person".

In special situations, our competent foremen are aware of the effects of the history of other construction in the area as well as the indication of subsurface profiles or soil types. We feel that for safety, these people best satisfy the intent of Sub-Part "P", and more important, they are constantly present. The requirement of any additional qualifications or specialized persons, such as a "registered engineer" is an unnecessary and excessive cost which we can't afford.

We feel the "engineer" is the appropriate requirement rather than the "competent" or "qualified person", when design of restraining systems to protect structures which usually are adversely affected by any movement are needed. For construction activities with protection of personnel who reasonably are more mobile, the need is different and less severe. We understand that in technical terms the contrast between these two situations would be described as the difference between the "at rest" and "active" states of lateral pressures.

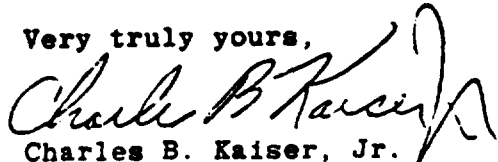
Since the great majority of our involvement is in trenching, the difference of stronger soil characteristics in short-term excavations must be recognized and we strongly endorse seven days as the suggested change from "short-term" to "long-term" situations (1926.653(m) and (t))

We urge that the revision of Sub-Part "P" be as indicated in the working draft with "qualified person" being used rather than "engineer" in Section 1926.653, subparagraphs 2, 3, 41, c and d and that "short-term" excavations as compared with "long-

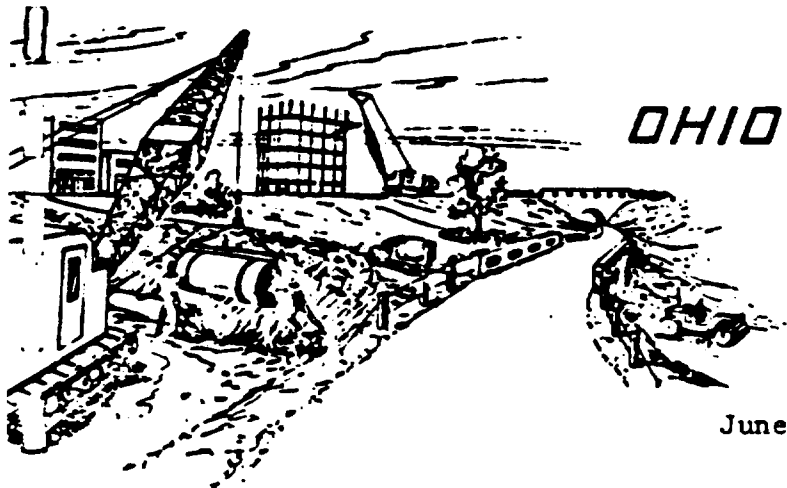
National Bureau of Standards  
July 13, 1981  
Page Three

term" be defined as "seven days or less".

Very truly yours,

  
Charles B. Kaiser, Jr.  
Assistant Executive Director  
and General Counsel

CBK/kam



## OHIO CONTRACTORS



*Association*

THE NEIL HOUSE MOTOR HOTEL  
COLUMBUS, OHIO 43215 • 228-6831  
LONG DISTANCE TELEPHONE 800 282-1388

June 1, 1981

Mr. Felix Y. Yokel  
U.S. DEPARTMENT OF COMMERCE  
NBS Building Science Series 127  
Washington, D.C. 20234

Dear Mr. Yokel:

A review has been made by our safety committee and others, of proposed subpart P. 1926.650 - .651 - .652. The Ohio Contractors Association represents 408 contractors in the state of Ohio. This response to this proposal should be considered as representative of our complete membership. The following is a summary of the evaluations by the membership of the proposed standards.

1. The intent of the revised changes of subpart P. to clarify and simplify the standards has in the main, failed. The main problem, that of soils classifications, has not accomplished its goal. The new descriptions are as confusing as the old, if not more so. Years of experience by "competent persons" indicate that the safety of persons in trenches with sides of "intact hard" soils need no more than a  $\frac{1}{2}$  to one slope when the depth is 12 ft. or less.
2. Unanimous agreement of the need for section 1926.65a however we suggest changed wording as follows:  
"Utility companies and municipally owned utilities shall be contacted and advised of proposed work prior to the start of actual excavation. Prior to opening an excavation effort shall be made to determine whether underground installations i.e. sewer, telephone, electric, water, fuel lines etc. will be encountered and if so where such underground installations are located".
3. Pg.7 .651(d) the wording is not clear and would imply that the backhoe digging the trench would be the cause for added shoring.

(Continued)



Pg.7 paragraph(g) should be deleted. The use of stop logs is not in common use by the industry and would create greater hazards, from the constant moving, than it would eliminate.

Pg.7 item(h) a better definition of conditions are needed to fully explain the intent of this paragraph.

Pg.7 paragraph(i) conflicts with provisions of the Clean Waters Act and is meaningless when it starts "If Possible".

Pg.7 paragraph(j) The procedures do not seem warranted in open cut trenching. What is meant by "Attended emergency rescue equipment?"

Pg.8 paragraph(r) the "5 ft." depth is consistent with other standards and is the level where a need would be greater.

Pg.8 paragraph(r) shoring members "secured to prevent failure" is unclear.

Pg.9 Trenching and Large excavations should be separately dealt with by two distinct set of standards.

Pg.9 paragraph(a)(1)(b) a clearer definition of "unfractured rock" is needed.

Pg.9 paragraph(a)(2) we urge the adoption of the 24 ft. depth.

Pg.9 paragraph(a)(2)(a) the use of a "qualified person" is more practical, allowing immediate determinations and corrections in the field when questions arise.

Pg.10 paragraph(a)(3) we favor the 24 ft. depth in this item and the determination of proper protection by a qualified person."

Pg.10 paragraph(b)(1) 7 days would be a more practical time frame for short term excavations.

Pg.11 table 1 we urge  $\frac{1}{2}$  to 1 slope in soils type A. and a separate table for short & long term excavations & trenches.

Pg.11 Notes item 4 the description is ambiguous and needs clarification.

(Continued)

Pg.12 the 3 ft. depth is too confining for many installations and conflicts with good engineering practice. The illustrations will create interpretation problems by persons unfamiliar with this type of work. The table in case IV should be revised.

Pg.14 & 15 this section has no practical use for field personnel and creates more confusion than it answers questions about safe procedures. Keep diagrams, tables and examples simple.

Pg.16 paragraph(c) we would prefer to use a "qualified person".

Pg.16 paragraph(5)(i) when this condition exists many times it is impossible because of pipes, lines or other devices to achieve this requirement.

Pg.16(5)(iii) the use of 3 ft. will give greater flexibility in various soil conditions without increasing hazard exposure.

Pg.17 b refer to Figure 4 pg.20.

Pg.18 Mass movement of Soil or Rock definition will reduce interpretation of requirement.

Pg.19(b) A more comprehensive definition of "fractured rock" will eliminate interpretation confusion.

Pg.19 paragraph(m) 7 days should be used.

Pg.19 paragraph(t) 7 days should be used.

Pg.19 paragraph(x) include this definition with the definition of fractured rock.

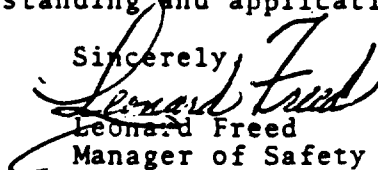
Pg.20 paragraph(bb) an example would clarify this definition.

Pg.21 thru 50 should be deleted. In our opinion this section has no practical application or use in the field. Many of the formulas and computations are available to engineers if there was a need.

Pg.57 table P-2 should be reworded to allow for greater spacing between shoring members to be able to handle longer lengths of pipe being used today.

These recommendations and suggestions are offered in the hope that they will contribute to increased understanding and application of regulations to improve safety.

Sincerely,

  
Leonard Freed  
Manager of Safety

I.F/nas

5. ATLANTA, GEORGIA, WORKSHOP - WRITTEN COMMENTS AND CORRESPONDENCE

P. O. BOX 33189

**DUKE POWER COMPANY**  
**GENERAL OFFICES**  
422 SOUTH CHURCH STREET  
**CHARLOTTE, N. C. 28242**

TELEPHONE: AREA 784  
372-4811

July 17, 1981

Felix Y. Yokei  
U.S. Department of Commerce  
National Bureau of Standards  
Washington, D.C.

Re: Review of Working Draft of Suggested Revision in Subpart P  
of the Safety and Health Regulations for Construction Part  
1926, Excavations and Trenching based on Building Science Series  
Report BSS127

The attached Summary represents Duke Power Company's Construction  
Department's views on the suggested revision to subpart P of the  
OSHA 1926 Standards.

If further interpretation or comment is needed please do not hesitate  
in contacting my office.

J E Grogan, Manager  
Construction Resources

*R S Dugan*  
R S Dugan, Supervisor  
Construction Safety

JFE:sr

cc: David Abernethy



## Proposed Review

<u>Reference</u>	<u>Response</u>
1926.650(c)	It is requested that planking material and their use be specified in construction of raised walkways, runways, or sidewalks to insure an acceptable level of safety.
1926.650(j)	It is recommended that a qualified engineer be responsible for the critical function of inspection, design, and other related decisions concerning trenching and excavations. By the criteria document definition "qualified" carries more recognition and proven ability than does "competent". It is recommended that the engineer not be required to work at the location since multiple sites would present availability problems.
1926.651(e)	There is some concern on the proposed regulation to shore the sides of excavations as necessary where trucks and other vehicles may be parked or moved adjacent to the edges. It is agreeable that employees should not be in such a trench while a piece of equipment is nearby but the wording of the regulation may cause concern in back-filling operations where the truck is backed and dumped from the excavation or trench edge.
1926.651(f)	Where blasting is necessary then the soil should be treated as unstable in regard to shoring considerations.
1926.651(g)	The question is raised as to how adequate a barricade or stop log would be required as a stop for vehicles adjacent to excavation or trenches. Warning flagging may be adequate to similarly safeguard all employees.
1926.651(i)	It must be considered that <u>oil</u> cannot be used to minimize dust conditions caused by trenching and excavating activity where prohibited by some states (example-South Carolina) as a hazardous waste chemical and other government environmental agencies and regulations.
1926.651(o)	This section referring to work procedures in bell-bottom pier holes should <u>not</u> be dropped from the scope of subpart P since <u>it</u> deals with a type of excavation.

<u>Reference</u>	<u>Response</u>
1926.651(p)	The 4 feet depth requirement should be retained as a basis for requiring adequate means of exit from a trench. The phrase "negotiable slope" is vague and needs clarification.
1926.651(q)	The proposed regulation should read "shoring where needed" to clarify the intent of the standard.
1926.652(a)(2)	Excavation standards should not be relaxed to allow depth requirements to be extended from 20 ft. to 24 ft. before following specific requirements. The majority of excavations are less than 20 feet where the majority of injuries have been shown to occur.
1926.652(figure 1)	Slope requirements in the drawing should be omitted since the angle of repose would be a primary governing factor in determining shoring.
1926.652(figure 2)	Case IV should be limited to excavation by trenching machines.
1926.652(figure 2)	The allowable bank next to the work area should remain at 3 feet and not increased to 4 feet in the interest of increased safety to workers.
1926.652(table 1)	The steepest allowable slope should remain at 1:1 instead of 3/4:1 to allow a greater margin of safety.
1926.652(b)(1)	A short term excavation or trench should be redefined to extend from 1 to as much as 3 days.
1926.652(b)(4)(ii)	This information requiring specified strength of protection systems for trenches and excavations should be inserted at the end of subpart P with more options outlined.
1926.652(b)(5)(iii)	Excavation up to 2 feet below the bottom of trench boxes or sheeting should remain as a requirement and not extended to 3 feet.
1926.653(a)	The reference to a registered architect should be removed since the expertise of this field may not be concerned with soils.
Definition:	Mass movement of soil should be defined to give guidance in inspection and design specifications.
Appendix A	There is general use of the term "should" which perhaps to insure worker safety should be changed to "shall" items. Examples: A.3,2 Soil and Water Loads

There was concern from the workers responsible for actually installing shoring systems that more emphasis should be placed on system installation safety. The standards address finished shoring systems for other work processes but not in particular to how they are actually constructed as to working in trenches and excavations. This important area needs further consideration.

6. DALLAS, TEXAS, WORKSHOP - WRITTEN COMMENTS AND CORRESPONDENCE

**DRAFT**

**DISCUSSION OF:**

**WORKING DRAFT OF SUGGESTED REVISION IN SUBPART P OF  
THE SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION  
BASED ON BUILDING SCIENCE SERIES REPORT BSS 127**

**by Felix Y. Yokel**

**by**

**BUILDING AND CONSTRUCTION TRADES DEPARTMENT AFL-CIO  
JACK L. MICKLE**

**DALLAS, TEXAS**

**JUNE 30, 1981**

# DRAFT

Dr. Yokel is to be commended for his efforts to improve upon the Occupational Safety and Health Administration, (OSHA), 29 CFR Part 1926. Subpart P, Excavation, Trenching and Shoring Regulations document.

The Building and Construction Trades Department, AFL-CIO has been supportive of and assisted Dr. Yokel, where possible, since he began work on this project with the National Bureau of Standards in June, 1976.

In January, 1977 the B&CTD began the planning stage of a "Trenching Hazard Identification Task Force", hereinafter called the Task Force, to help the NBS obtain employee input aimed at hazard identification. In March, 1977 the Task Force met for a four day "retreat" type workshop; the six labor and management members brought with them 182 years of experience in trenching and related work. The charge was "to identify procedures and conditions that create safety hazards during excavation and trenching operations". Others present for the deliberations were Jim E. Lapping, Director of Safety and Health, B&CTD, as coordinator; Felix Y. Yokel as Technical Observer for the NBS and Jack L. Mickle, Chairperson. The final report (1)\* was filed with the NBS in April, 1977. The final report appears in appendix G of NBSIR 80-1988 (2).

In September, 1978 Dr. Yokel (3) presented the preliminary findings and recommendations of the NBS study. Out of that two-day workshop came the agreement for this series of workshops to bring the results of Dr. Yokel's NBS study to the attention of labor, management and engineers in the field. Actually the essence of the working draft we are using for this workshop was printed in the Concrete Pipe News (4) in April of this year.

Since the 1978 workshop the B&CTD has responded to a number of requests for criticisms of drafts by Dr. Yokel.

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\* Numbers in parentheses refer to references given at the end of this paper.

DRAFT

Two premises underlie all remarks and criticisms given in this critique:

That the worker be assured of safe and healthful working conditions, and

that the journeyman worker and the compliance officer as well as the management representative be able to fully understand the precautions that have been taken and the protective measures that have been provided to assure worker safety and health, or that the safety of the worker on the job be placed in the hands of a licensed professional.

The first premise is spelled out in the preamble of the Occupational Safety and Health Act of 1970.

The second premise assumes that an average journeyman or compliance officer, using the official OSHA regulations governing excavation and trenching safety, can determine whether or not the safety provisions on any jobsite are in compliance with the appropriate regulations. If the provisions are not "standard practice" as outlined in the regulations then there must be a certificate issued by a licensed professional which assures the worker that the jobsite safety and health measures have been designed by and certified by the licensed professional.

There are undoubtedly many "competent persons" and "qualified persons" who are quite capable of designing a safe worksite, but how are they to be identified by the worker or compliance officer? The license is the evidence. All licensing laws have encountered competent or qualified persons and have eventually incorporated them into or excluded them from practice. While there are probably quite capable people who know a great deal about medicine or law, the prudent individual seeks the licensed practitioner when medical or legal opinions or services are sought.

Actually suggesting that registered engineers need to be consulted is not new with this suggestion. Thompson and Tanenbaum (5) recommend substantial involvement of registered engin-

# DRAFT

ers in construction activities requiring trenching or excavations.

In view of the foregoing, this discussion will be concerned with only the first 20 pages of Dr. Yokel's working draft which outlines "standard practice". Even portions of the first 20 pages probably belong in the "guidelines" which have been included to assist professionals. It is also assumed that only the "standard practice" will eventually be recommended for inclusion in the OSHA regulations Subpart P; Dr. Yokel has indirectly suggested that by what was included in the article which he co-authored in the Concrete Pipe News.(4).



# DRAFT

## COMMENTS ON SELECTED ITEMS ON PAGES 1-20 OF THE WORKING DRAFT

### Page Location Comment

- |     |                      |   |
|-----|----------------------|---|
| 1   | item 3               | "boxes. It is addressed to contractors, shoring manufacturers and engineers..." Why address it to the contractor unless the contractor is also an engineer?   |
| 2   | item 5               | "...which would aid field personnel and contractors in the selection of shoring." Once again, these persons are going to be dealing with the standard practice unless they are licensed professionals in their own right.                 |
| 2   | last line            | Note that a qualified person is not an engineer (recognizing this as just an example)   |
| 3&4 | All Issues           | The items listed on pages 3 and 4 will be considered individually as they encountered in the text.  |
| 5   | (g)                  | ..be provided with and shall be instructed (required) to wear ....  |
| 5   | (i)                  | ...shall be permitted under loads handled by power-shovels, derrieks, or hoists (equipment). This item is too specific for not listing all equipment which is used to handle loads; for example, backhoes are not listed.                 |
| 6   | (j) 2nd para. line 8 | ...or the shoring system, and shall increase protection against slides and cave-ins if necessary (see that all work in the excavation shall cease until necessary precautions have been taken to safeguard employees.)                    |
| 6   | (c)(1) line 3        | "..shall be effectively stored and retained at least 2 (3) feet or more from the edge of the excavation." The Task Force specifically stated that 3 feet was necessary for proper protection.   |
| 6   | (c)(2) line 3        | "...may use effective barriers or other effective retaining devices in lieu thereof in order..." Task Force recommended extending tight sheeting above ground level as an effective barrier. Twelve to 18 inch extensions were discussed. |
| 8   | (l) line 2           | "... equipment, they shall be designed and constructed by qualified persons..." Design implies work done by a licensed professional.  |
| 8   | (o)                  | This item is silent with respect to straight sided pier holes; some confusion has arisen because 1926, straight sided holes are covered elsewhere. 800(h)(3)  |
| 8   | (p)                  | When employees are required to be in trenches 4 {5?} feet deep...." Leave at 4 feet.  |

# DRAFT

Page	Location	Comment
8	(s)	"...boxes or shields are used they shall be designed (and certified as to use by a professional engineer and shall be maintained in a manner which will provide protection for the worker.)" Strike the balance of (s).
9	(a)(1)a	Excavations less than 5 ft. deep, except when examination-of-the-ground-by-a-competent-person-indicates-that hazardous ground movement may occur."
9	(a)(2)	"Excavations from 5 ft. to 20 ft. (24-ft. 21 deep. Why consider 24 feet? A better choice might be 15 feet for Standard Practice. Thompson and Tanebaum data (5) indicate that 87 per cent of the fatalities and injuries occur in excavations less than 20 feet deep and that 72 per cent occur in those less than 15 feet deep. Hinze and Carino (2) state in their summary that their "...study showed that most trenchwork is between 5 and 15 feet deep with the trench width usually being about 3 feet." Cass (6), speaking about the stacking of two standard 7 ft. aluminum hydraulic shores, notes that where the trench is over 14 feet deep (page 68) "other shoring systems should be applied" and on (page 72) "Maximum trench depth, this method, is 15' (4.58 m). Over 15' (4.58m), see Fig. 60.2, multi-type shoring." Multi-type shoring shown on Fig 60.2 is a different system using aluminum hydraulic shoring and plywood backing. A maximum depth of 15 feet for Standard Practice seems appropriate.
9	(a)(2)a line 3	"...sloping requirements must be determined by an engineer {a-qualified-person?}-"
9	(a)(2)b Figure 1	May lead an individual to believe that FOOTING A is not a cause for concern; this could be dangerous. It is worthy of note that the role of the engineer has not been challenged at this point where property damage as well as personal injury is possible.
10	(a)(3)	See comments under: page 9 (a)(2). Fifteen ft. depth may be a better limit for Standard Practice rather than 20 ft.
10	(b)(1) line 6	The distinction between short-term and long-term is very difficult to reckon with; virtually no firm data exists. Not only stresses in the mass vary with time, but environmental factors may be critical. Twenty-four hours seems more logical than seven days.

# DRAFT

Page	Location	Comment
11	bottom of page last two lines	There may be some merit to allowing steeper slopes in some cases. The Task Force indicated that slopes flatter than 1:1 were probably not necessary for worker safety. Slopes of 1:1 were recommended for most conditions.
12	Fig. 2 Case IV	This particular configuration should be made a part of the "guidelines" proposed by NBS. While the configuration looks good on paper, it may be difficult to understand and/or enforce in the field. If included in Standard Practice the 3 ft. max bank should be retained.
13	(b)(4)(i)b.	See the first four lines at the top of page 13. Table 2 is necessary in Standard Practice only if Fig. 3(b) is retained. Moving the option shown as Fig. 3(b) to the Guidelines removes the need for Table 2 which is confusing and also removes the need for special tables and figures outlining the placement of shoring in the lower part of the ditch.
13	(b)(4)(i)c.	For Standard Practice it may be worthwhile to include all surcharges, including allowances for heavy equipment, in the adjusted depth. The Task Force recommended a minimum of 300 pounds per square foot for surcharge. Dr. Yokel has greatly simplified Table 3 but it still can be confusing. Moving Table 3 to the Guidelines and greatly increasing the surcharges to allow for heavy equipment may lead to "overdesigned" shoring and shields, but Standard Practice would thereby be greatly simplified.
13	(ii)b.	The Task Force recommended a 500 lb gravity load.
13	(ii)c.	This statement is not clear. Does this mean a 240 ft-lb impact load per square foot? The entire (ii)c. should become a part of the Guidelines and removed from Standard Practice.
13	(ii)	This entire section devoted to the required strength of shoring systems, trench shields and trench boxes needs to be moved to the Guidelines.
16	b.	If some of the previous suggestions are followed, hydraulic shores and other assemblies can be brought into Standard Practice. At a meeting in October, 1980 with NBS and members of the hydraulic shoring industry it was agreed that reasonably simple charts for the selection of shores can be developed. This seems to be in keeping with Cass' (6) recommendations for depth to 14 or 15 ft. There is no question that the resulting system would be greatly over-designed

Page	Location	Comment
		at times, but the freedom to use Standard Practice for most work (2) and thereby not requiring the services of an engineer seems to outweigh the disadvantages of overdesign.
16	c.	Timber shoring is properly located in the Guidelines; selection must be by an engineer. The Guidelines are for the use of licensed professionals.
16	(5)(ii) last two lines	The statement in parentheses is a vague performance specification which detracts from a well stated, precise paragraph.
16	(5)(iii)	Excavation below the bottom of the protective element has merit; exactly how much to allow is difficult to determine. Certainly engineers can design specific protection for unique circumstances, the Guidelines will help, but permitting excavation below the protection device in Standard Practice will require very careful consideration.
18	(a)	"...with standards required by a registered-architect, a registered professional engineer, or other duly licensed or-recognized authority. .."
19	(m)	Twenty-four hours for short term seems most reasonable.
19	(o)	Negotiable slope needs to be specified; 1½:1 seems reasonable.
19	(p)	How is a qualified person to be identified? Unless there is a specific procedure anyone can claim to be a qualified person. No objection if the qualified person is permitted to use Standard Practice only.
19	(t)	same argument; use 24 hours for short term.
19	(aa)	<u>Stable Slope</u> . A meaningless term unless it is arrived at by a licensed engineer. This term has no place in Standard Practice!
20	(gg)	Working loads are best relegated to the Guidelines where they can be dealt with by an engineer.

# DRAFT

## Summary

There must be clear separation between Standard Practice and cases where an engineer has certified the procedure to be followed.

It is recommended that Standard Practice be permitted to a depth of cut of 15 feet; this includes most excavation and trenching work. At depths greater than 15 feet, or for special work, the engineer must assume full responsibility for the design of the protective system. The 15 ft. depth needs verified.

Standard Practice must be written such that the protective measures resulting from the application of Standard Practice are observable, measurable, understandable by all parties (with application of the regulations) and provide for the safety and health of the worker. It is recognized that Standard Practice may at times result in substantial overdesign, but this would not be new to the construction field.

It is anticipated that competent or qualified persons working for the contractor would select methods within Standard Practice to protect workers, but that any deviation from Standard Practice would need to be designed by an engineer. The engineer is recognizable by a professional license.

Several items which need consideration: construction right of way requirements, toxic materials, safety program as an item in the bid document, soil conditions and utilities in the bid document and better safety education for all. The Task Force final report lists other concerns.

# DRAFT

## RECOMMENDATIONS

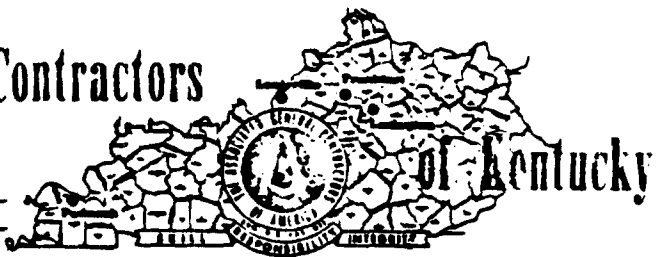
1. Use Standard Practice to a depth of 15 feet.
2. Over 15 feet or where Standard Practice is changed an engineer must assume full responsibility.
3. Standard Practice must be observable, measurable and understandable by all parties and above all must be effective.
4. Competent and qualified persons working for the contractor would select methods within Standard Practice but an engineer would be required where deviations occur.
5. Construction right-of-way needs to be considered.
6. Toxic materials need to be considered.
7. A safety program needs to be outlined in the bid documents.
8. Soil conditions and utilities need to be considered in the bid documents.
9. Safety education is a must for all.

**DRAFT**

**References**

1. Building and Construction Trades Department AFL - CIO. Trenching Hazard Identification Task Force; Final Report. Prepared for the National Bureau of Standards; Building Safety Section; James O. Bryson, Chief. April, 1977.
2. Hinze, Jimmie and Nicholas J. Carino. A Study of Work Practices Employed to Protect Workers in Trenches; NBSIR 80-1988. National Bureau of Standards. March 1980.
3. Salomone, Lawrence A. and Felix Y. Yokel. Proceedings, Federal Workshop on Excavation Safety, September 19 and 20, 1978. National Bureau of Standards. July, 1979.
4. Yokel, Felix Y., Riley M. Chung and Ronald L. Stanevich. New Concepts for Construction Practice Standards for Excavations. Concrete Pipe News; pages 28-33, vol 33 no 2, April, 1981.
5. Thompson, Louis J. and Ronald J. Tanenbaum. Excavations, Trenching & Shoring: the responsibility for design and safety. Sponsored by the Associated General Contractors of America. A report of the Texas A & M Research Foundation. College Station Texas. September, 1975.
6. Cass, W. Martin "Red". Common Sense in the Common Trench. Equipment Guide-Book Company; 2800 West Bayshore Road, Palo Alto, California 94303. 1979.

# Associated General Contractors



Office in FRANKFORT, LEXINGTON, LOUISVILLE and PADUCAH

Please Address Reply To:

## RECOMMENDED CHANGES TO WORKING DRAFT SUBPART P 2/20/81

- Page 5 1926.650(d) Reword "Planks shall be installed in a manner to reduce the probability of tripping."  
(g) Need to define what is meant by "Exposed To Vehicular Traffic".  
(i) To restrictive; does not allow for the driver to stay in vehicle with cab protection. In most cases driver is exposed to a greater hazard outside of his/her vehicle. Remove second sentence.
- Page 7 1926.651(g) Remove words "substantial stop logs or barricades shall be installed." Reword: If possible, the grade should be away from the excavation, when mobile equipment is utilized or allowed adjacent to excavations.  
(i) Delete (This provision is covered under Air Pollution Standards).  
(k) Delete (Should only apply to long term usage).
- Page 8 Delete (Any structural ramp of this type would normally be in the project plans and specifications).  
(p) Support the 5' trench. Also consideration should be given to the exit through pipes (48" in diameter and larger) in the trench. This would eliminate the emergency exit on a ladder with mud on the boots.  
(q) Start paragraph with words "Proper Shoreing".  
(r) Delete: repetitive of (q).  
(t) Delete: Does not define unstable soils; to restrictive.
- Page 9 1926.652(a) (2) Support 24 foot.  
(2)(a) Support qualified person.
- Page 10 (3) Support 24 ft. and an engineer.

Page 11	Table 1	Soil Type	12' or less	12' & greater	Start Sloping
		A	$\frac{1}{2}$ :1	$\frac{1}{2}$ :1	5' level
		B	3/4:1	1:1	3' level
		C	1:1	1:1	0' level



Notes: 1) Use of Normal Construction Equipment used in the Trenching operation should not change the sloping requirements.

2) Type C: Soft Soils should not include cohesive soils defined under d/.

Page 12 Figure #2 Should be changed to consider depth at which slope would start. (See recommendations under Table 1).

Page 13 b. To restrictive.

Page 14 Table #2 More time for study is needed.

Additional comments:

1. Too much emphasis is placed on sheeting and shoring systems for semi-permanent excavations, such as building foundations?
  - a) Concentration in regulation changes seems to be on building excavations.
  - b) Greatest need is for uniformity of enforcement, clarification of regulation and training of compliance officers is in open trenching projects.
  - c) Regulations, even with proposed changes are still not simple enough for average compliance officer to comprehend. Regulations are not definitive enough to accurately classify various soil types. Most charts are thrown out window when decision as to bracing is made. Most superintendents rely on experience.
2. All backfill material is not soft or unstable, yet regulations assume so.
3. 1926.651(c) is redundant, is covered in several other regulations.
4. Short term trench opening should be less restrictive and should re-consider the effect weather has on long term trench opening, in evaluating soil type

Presented: June 16, 1981, Atlanta, Georgia

Comments Made by: Michael D. Maguire on behalf of A.G.C. of Kentucky which represents Chapters in Louisville, Lexington and Paducah, Kentucky.

McCLURG & ASSOCIATES, INC./CONSULTING ENGINEERS

June 25, 1981



Efficiency Production, Inc.  
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Attn: Mr. John Cook

Re: Comments on "Working Draft of Suggested Revision  
in Subpart P of the Safety & Health Regulations  
for Construction based on Building Science Series  
Report BSS 127" by Felix T. Yokel dated 2/20/81

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1926.652 - Specific Shoring, Shielding & Sloping Requirements

- (a) (1) a. Change to excavations less than 4 ft. (vs. 5 ft.)
- (a) (2) Change to excavations greater than 24 ft. (vs. 20 ft.)
  - a. ... 'must be determined by an engineer'.
- (a) (3) Change to 24 ft. (vs. 20 ft.) and use engineer (vs. qualified person)
- (b) Standard Practice
  - (1) Change to 7 days (vs. 24 hours) -(this needs documentation or at least more study).
- (4) (1) Determination of adjusted depth
  - (a) eliminate the 2' surcharge here and in Figure 3 (a), therefore adjusted depth equals actual depth H as determined by a qualified person
  - (b) eliminate the 2' surcharge in figure 3 (b), make adjusted depth equal to actual depth.

Page 14 - eliminate Table 2.

(Discussion - the 2' allowance for spoil piles is not needed in many cases, e.g. paved streets - traffic maintained; and is not enough in many other cases erring on the side of danger. The design depth should be selected by a qualified person based on actual field

June 25, 1981

conditions. This obviously includes spoil piles (which may be 10 ft. instead of 2 ft.) and any other surcharge loads which must be included in the estimation of depth of cut. Table 2 is an effort to lay down empirical rules for adjusting depths but it is not controlling and merely will confuse field personnel. We assume this table is based on a Rankine or Coulomb theory for sloping backfill utilizing a failure wedge of earth loading the retaining structure. The actual depth would control until you arrive at an exceedingly deep cut. For example, if  $H = 20$  ft., slope 1:1, adjusted depth equals 3 times  $H$  equals 60 ft., which means within the normal range of excavation the actual depth of cut must exceed 60 ft. before Table 2 controls. Hopefully in excavation decisions of this magnitude an engineer would be investigating a method of determining lateral earth pressure based on engineering principles and accepted soils mechanics data available to him and Table 2 would be of no value to him.)

(4) (1)

- c. delete the reference to a 2 ft. surcharge allowance. (Table 3 and Figure 3 (c) would probably be helpful to field personnel who might be required to evaluate the effects of heavy equipment in close proximity to the trench excavation for depths up to 20 ft.)

Page 11 - Table 1

Type B medium soil should be  $w_e$  30 lbs./ft<sup>3</sup> in accordance with generally accepted engineering practice. This covers sand, gravel, sand-gravel, clayey sand-gravel and silty sand with unit weights ranging from 100 to 140 lbs./ft<sup>3</sup> and friction angles from 28 to 45 degrees. Soil classifications exerting pressures greater than 30 lbs./ft<sup>3</sup> such as clay-silt, clays, uniform silts and hydrostatic conditions are special cases which generally exert pressures greater than 40 lbs./ft<sup>3</sup> and require more detailed analysis.

We also fail to understand why the "steepest allowable slope" should be any different for depths greater than 12 ft. then it is for depths less than 12 ft. We propose they should be as follows in accordance with average angle of repose, regardless of depth:

Type A	3/4 horizontal	: 1 vertical
B	1/2 horizontal	: 1 vertical
C	3 horizontal	: 1 vertical

(4) (ii) Required Strength of Shoring Systems

- a. Change to - lateral pressure at the bottom of excavation equal to the equivalent weight effect ( $w_e$ ) in Table 1 times the depth of cut with lateral pressure diagram appropriate to the construction as determined by an engineer. (Discussion - the present statement is an over simplification more correct for closely cross braced sheeting, but not applicable to trench boxes and not correct for all cases of braced sheeting).
- c. Delete the entire last sentence. Allowing a 33% allowable stress increase would reduce the safety factor against yield for A36 steel to 1.12. This approach is not recognized by any known building code and if reasonable criteria is used for determining lateral earth pressure it is unwarranted.

(5) Special Provisions

- (iii) Excavation up to 3 ft. below the bottom of ....

1926.653 Definitions

- (m) Long term excavations - which are open more than 7 days.
- (t) Short term excavations - which are open 7 days or less.

Guidelines Supplementing Subpart P of the Safety and Health Regulations for Construction

Page 22 - Section 2 Strength Requirements for Pre-Designed Shoring Systems, Trench Boxes and Trench Shields to be used in the Standard Practice.

2.1 Design of Shoring Systems

- A. Delete the 33% increase in working stress. The lateral pressures should be accurately estimated and no distinction made in working stresses as to short or long term loading.
- B. Delete 1.3 times the working load - use 1.7 for short and long term excavations.

2.2 Loads Acting on Shoring Systems, Trench Shields and Trench Boxes

- 2.2.3 Lateral Soil Pressures - See comment (4) (ii) a. Trench boxes are designed on the basis of yielding supports for active soil pressure rather than passive pressures as in the case of cross braced sheeting with nonyielding supports. This entire section should be re-written to make this distinction.

Efficiency Production, Inc.  
Page 4  
June 25, 1981

Page 25 - Figure 1. Lateral earth pressure diagrams are for braced sheeting, this figure should be revised or supplemented with diagrams applicable to trench boxes, i.e. triangular or prismatic not rectangular.

#### 2.3.2 Rating Procedures

The annual renewal of this rating may be a worthy objective but is impractical and not enforceable. Why not a statement to the effect that it is the contractor's responsibility to periodically inspect trenching equipment and insure they are in satisfactory condition.

Page 37 Section 5 (b) Delete last sentence allowing 33% increase

Section 5 (c) Delete "1.3 times the working load for short-term excavations.

Page 40 Add lateral earth pressure diagrams for the active soils case utilizing Rankine and Coulomb earth pressure solutions.

Respectfully submitted,

McCLURG & ASSOCIATES, INC.

  
Allen J. Nieber, P.E.

AJN/cj

*Deposition in  
Dallas Workshop*

STATEMENT OF POSITION AND RECOMMENDATIONS ON REVISION  
TO SUBPART P OF THE SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

PRESENTED BY

THE MAJOR MANUFACTURERS OF TRENCH BOXES  
AND TRENCH SHIELDS OF THE UNITED STATES

John B. Cook  
Efficiency Production, Inc.

Wendell Wood  
Griswold Machine & Engineering

#### GENERAL STATEMENT OF POSITION

A review in detail has been made of the proposed revisions in Subpart P 1926.650 - .651 - .652 and the attached guidelines and appendix.

This review was made by, and on behalf of, the major trench box manufacturers of the United States, and represents their consensus opinion of the changes in the proposed standards.

It is our position that the intent to clarify and simplify, as it relates to the revised changes of Subpart P, has failed, and in fact, has made it more confusing and more difficult to apply in the field. The proposed design criteria as they relate to trench boxes do not conform to accepted engineering practices, and at the proper time we have specific recommendations for changes in the proposed revisions.

1926.650 GENERAL PROTECTION REQUIREMENTS - NO COMMENT

1926.651 - SPECIFIC EXCAVATION REQUIREMENTS

PAGE

- 8 - item (s) Should read ... Portable trench boxes or sliding trench shields may be used for the protection of personnel. Where such trench boxes or trench shields are used they shall be designed, constructed and maintained in a manner which will provide equivalent protection to that provided by the shoring required for the excavation as defined by accepted engineering practice.

1926.652 - SPECIFIC SHORING, SLOPING AND SHIELDING REQUIREMENTS

PAGE

- 9 - item 2a Should read ... Qualified Engineer
- 10 - item b (2) b (3) Should read ... Engineer
- 10 - item (b) (i) Change to 7 days
- 10 - item (4) (i) Based upon the education, training and experience of our professional engineers, it is our position that there is no foundation in standard practice for the application of an adjusted trench depth standard as delineated in section 1926.652 (b) (4) (i). We recommend that this section and it's tables 2 and 3 and figure 3 be eliminated in their entirety.
- 10 - item (4) (i) a We recognize the importance of surcharge loads and it should be dealt with within the realm of accepted engineering practice. We recommend the elimination of section 4 i - a,b, and c and table 2.
- 11 Regarding table 1 on page 11 - type B medium soil should be (we) 30 lbs./FT<sup>3</sup> in accordance with generally accepted engineering practice. Regarding slopes in table 1 page 11 - the steepest allowable slope table, in our opinion, does not conform to standard engineering practice
- 13 - item (11) a Should read ... lateral pressure at the bottom of excavation equal to the equivalent weight effect (We) in table 1 times the depth of cut with lateral pressure diagram appropriate to the construction as determined by an engineer.



- "We object to the footnotes attached to table 1 as being too technical and overly complicated for interpretation by field personnel, and recommend they be simplified."
- 13 (ii) c      The last paragraph of this section should read....shoring systems shall be designed in accordance with accepted engineering practices.
- 13 (iii)  
Paragraph 2      Should read... Shoring systems and trench shields shall be selected in the field on the basis of accepted engineering practice.
- 13 (iii) (a)      Trench shields, trench boxes, and pre-fabricated strutwale assemblies and other pre-fabricated assemblies shall be rated for the maximum depths in Type A, B, and C soils in which they can be used and selected accordingly.
- 16 - item (4) (iii) (c)      Should read.... prepared by an engineer.
- 16 - item (5) (iii)      Should read ... Excavation up to 3 feet below the bottom of sheeting, trench boxes, or trench shields, excavation up to 3 feet below the bottom is allowable in short term excavations. (and we agree with items a & b.)
- 1926.653 - DEFINITIONS APPLICABLE TO THIS SUBPART
- 18 a      Should read ... Accepted engineering practices, those requirements or practices which are compatible with standards required by a registered professional engineer.
- 18 c      We recommend the elimination of this item.
- 19 m      Should read... Long term excavations are excavations that are open more than 7 days.
- 19 o      Should read... Negotiable slope is a slope on which a person can egress from or ingress to an excavation with relative ease and speed to insure reasonable safety.
- 19 t      Should read... 7 days or less.
- 19 z      Should read... See figure 4. (Correction)

## GUIDELINES SUPPLEMENTING SUBPART P

### Page

- 22 - 2.1 First paragraph should read... Shoring systems, trench shields, and trench boxes shall be designed in accordance with accepted engineering practices.
- 22 - 2.1 A Should read... Are not to exceed 1.0 times the allowable working stresses....
- 22 - 2.1 B Change 1.3 to 1.7
- 22 - 2.23 Should read... Lateral pressure at the bottom of excavation equal to the equivalent weight effect ( $w_e$ ) in Table 1 times the depth of cut, with lateral pressure diagram appropriate to the construction as determined by an engineer, and figure 1 should be eliminated.
- 27 - 2.3.2 We question how the annual renewal of the rating can effectively be accomplished.
- 30 "Is it the intent that Appendix A become a part of Subpart P?"  
If the answer is yes, and Appendix A is to become a part of Subpart P we would like to take exception to several specific items that, as they were applied to Subpart P, do not conform to accepted engineering practice."
- 37 - 5. (b) Should read... Allowable stresses should be determined in accordance with the applicable standards.
- 37 - 5. (c) Should read....Ultimate strength, rather than working stress design may be used whenever such a procedure is stipulated in the applicable standard or load capacity is determined by test. Ultimate loads should be taken as 1.7 times the working load in accordance with accepted engineering practice.
- 38 A.5.3. First paragraph is O.K.  
Add second paragraph, which should include a diagram covering the active soil pressure case utilizing either the Rankine or Columb solutions.

ANSWERS TO MR. YOKEL'S QUESTIONS

#1 No comment

#2 No comment

#3 No comment on 24 foot limitation.

On question of should qualified person be substituted for engineer...

"No, as it relates to this specific question. There are other areas in the working draft where qualified person should apply."

#4 7 days. We do not need more conservative requirements.

#5 We feel that the allowable slope in table 1 is not in accordance with acceptable engineering practice and that the stable slope concept should be used.

#6 No comment

#7 Yes, and should be conveyed as part of the definitions.

#8 No comment

#9 Yes

#10 Yes

#11 No comment

#12 No

#13 No - Statement should not be deleted.

7. SAN FRANCISCO, CALIFORNIA, WORKSHOP - WRITTEN COMMENTS,  
CORRESPONDENCE AND INFORMATION

STAFF:  
JAMES H. KLEINFELDER  
CYRIL M. McRAE  
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MICHAEL E. MAHONEY  
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## J. H. KLEINFELDER & ASSOCIATES

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ROBERT D. HOWELL  
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DAVID C. MATHY

July 10, 1981

Mr. Felix Yokel  
U.S. Dept. of Commerce  
National Bureau of Standards  
Bldg. 226, Rm. B162  
Washington, D.C. 20234

Subject: San Francisco OSHA Subpart P Workshop

Dear Felix:

Listed below are my comments on the workshop and OSHA Draft.

### General

I like your idea of an industry committee representing Contractors, Engineers and Workmen carrying the final draft to the powers that be in OSHA. This would have to be a well balanced committee. I imagine A.G.C. would represent contractors, ASFE the design profession, but I don't know who would represent the workmen.

### Specific Comments

1. I am not sure that those representing labor are informing their people that following the "standard of practice" or an "engineered" system will only reduce risk, not eliminate it.
2. Section 1926.651 (P)
  - . 5 ft. exit requirement sounds reasonable
  - . Wide excavations could be exempt
  - . I am not sure about large pipes
  - . Negotiable slope may be difficult to define
3. Section 1926.652 (a) (2)
  - . I don't believe that the standard of practice should go below 20 ft.
  - . An exploration program should be required in excavations deeper than 20 ft. In some cases it may be wise to have a geologist involved as well as geotechnical engineer. The geol./enr. should determine the design parameters. If a



professional engineer is required to design the shoring, he should be an engineer qualified in the area of shoring design. If you are not going to require a qualified engineer, some checking mechanism should be set up, requiring the signatures and dates of the designer and the checker. (A professional engineer may be required by law in some states).

4. Section 1926.652 (b) (1)
  - . Short term excavation cannot be dropped without revising your design loads. I can see the desirability to drop it in some localities, but not nationwide. Maybe it could be increased to 3 days. Many changes can occur in 7 days.
5. Page 11, Table 1
  - . The "stable slope" concept must be kept since the standard of practice is not conservative enough to be used blindly.
6. Page 12, Figure 2
  - . Four (4) ft. seems to be working in California.
7. Section 1926.652 (b) (4) (ii)
  - . I see no problem with the existing format.
8. Section 1926.652 (b) (5) (ii)
  - . No comment
9. Section 1926.652 (b) (5) (iii)
  - . The sentiment was for 2 ft.
10. This work is normally out of the Architects field.
11. I like the idea of having a competent person in the field. Certainly the designer will not be in the field.
12. Maybe it could be replaced with "soil or rock movement that can cause physical harm to workers."
13. Old Section 1926.651 (c)
  - . No comment

I appreciate the opportunity of attending your workshop.

Sincerely,

J. H. KLEINFELDER & ASSOCIATES

*Jim Kleinfelder*  
James H. Kleinfelder  
President

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JHK:dc  
cc: Bill Zoino



**DRAFT**

DISCUSSION OF:

WORKING DRAFT OF SUGGESTED REVISION IN SUBPART P OF  
THE SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION  
BASED ON BUILDING SCIENCE SERIES REPORT BSS 127

by Felix Y. Yokel

by

BUILDING AND CONSTRUCTION TRADES DEPARTMENT AFL-CIO  
JACK L. MICKLE

SAN FRANCISCO, CALIFORNIA

JULY 8, 1981

# DRAFT

Dr. Yokel is to be commended for his efforts to improve upon the Occupational Safety and Health Administration, (OSHA), 29 CFR Part 1926. Subpart P, Excavation, Trenching and Shoring Regulations document.

The Building and Construction Trades Department, AFL-CIO has been supportive of and assisted Dr. Yokel, where possible, since he began work on this project with the National Bureau of Standards in June, 1976.

In January, 1977 the B&CTD began the planning stage of a "Trenching Hazard Identification Task Force", hereinafter called the Task Force, to help the NBS obtain employee input aimed at hazard identification. In March, 1977 the Task Force met for a four day "retreat" type workshop; the six labor and management members brought with them 182 years of experience in trenching and related work. The charge was "to identify procedures and conditions that create safety hazards during excavation and trenching operations". Others present for the deliberations were Jim E. Lapping, Director of Safety and Health, B&CTD as coordinator; Felix Y. Yokel as Technical Observer for the NBS and Jack L. Mickle, Chairperson. The final report (1)\* was filed with the NBS in April, 1977. The final report appears in appendix G of NBSIR 80-1938 (2).

In September, 1978 Dr. Yokel (3) presented the preliminary findings and recommendations of the NBS study. Out of that two-day workshop came the agreement for this series of workshops to bring the results of Dr. Yokel's NBS study to the attention of labor, management and engineers in the field. Actually the essence of the working draft we are using for this workshop was printed in the Concrete Pipe News (4) in April of this year.

Since the 1978 workshop the B&CTD has responded to a number of requests for criticisms of drafts by Dr. Yokel.

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\* Numbers in parentheses refer to references given at the end of this paper.



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Two premises underlie all remarks and criticisms given in this critique:

That the worker be assured of safe and healthful working conditions, and

that the journeyman worker and the compliance officer as well as the management representative be able to fully understand the precautions that have been taken and the protective measures that have been provided to assure worker safety and health, or that the safety of the worker on the job be placed in the hands of a licensed professional.

The first premise is spelled out in the preamble of the Occupational Safety and Health Act of 1970.

The second premise assumes that an average journeyman or compliance officer, using the official OSHA regulations governing excavation and trenching safety, can determine whether or not the safety provisions on any jobsite are in compliance with the appropriate regulations. If the provisions are not "standard practice" as outlined in the regulations then there must be a certificate issued by a licensed professional which assures the worker that the jobsite safety and health measures have been designed by and certified by the licensed professional.

There are undoubtedly many "competent persons" and "qualified persons" who are quite capable of designing a safe worksite, but how are they to be identified by the worker or compliance officer? The license is the evidence. All licensing laws have encountered competent or qualified persons and have eventually incorporated them into or excluded them from practice. While there are probably quite capable people who know a great deal about medicine or law, the prudent individual seeks the licensed practitioner when medical or legal opinions or services are sought.

Actually suggesting that registered engineers need to be consulted is not new with this suggestion. Thompson and Tanenbaum (5) recommend substantial involvement of registered engin-

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ers in construction activities requiring trenching or excavations.

In view of the foregoing, this discussion will be concerned with only the first 20 pages of Dr. Yokel's working draft which outlines "standard practice". Even portions of the first 20 pages probably belong in the "guidelines" which have been included to assist professionals. It is also assumed that only the "standard practice" will eventually be recommended for inclusion in the OSHA regulations Subpart P; Dr. Yokel has indirectly suggested that by what was included in the article which he co-authored in the Concrete Pipe News (4).

# DRAFT

## COMMENTS ON SELECTED ITEMS ON PAGES 1-20 OF THE WORKING DRAFT

### Page Location Comment

1	item 3	"boxes. It is addressed to contractors, shoring manufacturers and engineers..." Why address it to the contractor unless the contractor is also an engineer?
2	item 5	"...which would aid field personnel and contractors in the selection of shoring." Once again, these persons are going to be dealing with the standard practice unless they are licensed professionals in their own right.
2	last line	Note that a qualified person is not an engineer (recognizing this as just an example)
3&4	All Issues	The items listed on pages 3 and 4 will be considered individually as they encountered in the text.
5	(g)	..be provided with and shall be <del>instructed</del> (required) to wear ....
5	(i)	...shall be permitted under loads handled by <del>power-shovels, derricks, or hoists,</del> (equipment). This item is too specific for not listing all equipment which is used to handle loads; for example, backhoes are not listed.
6	(j) 2nd para. line 8	...or the shoring system, and shall <del>increase protection against slides and cave-ins if necessary,</del> (see that all work in the excavation shall cease until necessary precautions have been taken to safeguard employees.)
6	(c)(1) line 3	"...shall be effectively stored and retained at least 2 (3) feet or more from the edge of the excavation." The Task Force specifically stated that 3 feet was necessary for proper protection.
6	(c)(2) line 3	"...may use effective barriers <del>or other effective retaining devices in lieu thereof</del> in order..." Task Force recommended extending tight sheeting above ground level as an effective barrier. Twelve to 18 inch extensions were discussed.
8	(l) line 2	"... equipment, they shall be <del>designed and</del> constructed by qualified persons..." Design implies work done by a licensed professional.
8	(o)	This item is silent with respect to straight sided pier holes; some confusion has arisen because 1926; straight sided holes are covered elsewhere. 800(h)(3)
8	(p)	When employees are required to be in trenches 4 {5?} feet deep...." Leave at 4 feet.

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Page	Location	Comment
8	(s)	"...boxes or shields are used they shall be designed (and certified as to use by a professional engineer and shall be maintained in a manner which will provide protection for the worker.)" Strike the balance of (s).
9	(a)(1)a	Excavations less than 5 ft. deep, except when examination-of-the-ground-by-a-competent-person-indicates-that hazardous ground movement may occur."
9	(a)(2)	"Excavations from 5 ft. to 20 ft. {24-ft-?} deep.." Why consider 24 feet? A better choice might be 15 feet for Standard Practice. Thompson and Tanebaum data (5) indicate that 87 per cent of the fatalities and injuries occur in excavations less than 20 feet deep and that 72 per cent occur in those less than 15 feet deep. Hinze and Carino (2) state in their summary that their "...study showed that most trenchwork is between 5 and 15 feet deep with the trench width usually being about 3 feet." Cass (6), speaking about the stacking of two standard 7 ft. aluminum hydraulic shores, notes that where the trench is over 14 feet deep (page 68) "other shoring systems should be applied" and on (page 72) "Maximum trench depth, this method, is 15' (4.58 m). Over 15' (4.58m), see Fig. 60.2, multi-type shoring." Multi-type shoring shown on Fig 60.2 is a different system using aluminum hydraulic shoring and plywood backing. A maximum depth of 15 feet for Standard Practice seems appropriate.
9	(a)(2)a line 3	"..sloping requirements must be determined by an engineer {a-qualified-person?}."
9	(a)(2)b Figure 1	May lead an individual to believe that FOOTING A is not a cause for concern; this could be dangerous. It is worthy of note that the role of the engineer has not been challenged at this point where property damage as well as personal injury is possible.
10	(a)(3)	See comments under: page 9 (a)(2). Fifteen ft. depth may be a better limit for Standard Practice rather than 20 ft.
10	(b)(1) line 6	The distinction between short-term and long-term is very difficult to reckon with; virtually no firm data exists. Not only stresses in the mass vary with time, but environmental factors may be critical. Twenty-four hours seems more logical than seven days.

# DRAFT

Page	Location	Comment
11	bottom of page last two lines	There may be some merit to allowing steeper slopes in some cases. The Task Force indicated that slopes flatter than 1:1 were probably not necessary for worker safety. Slopes of 1:1 were recommended for most conditions.
12	Fig. 2 Case IV	This particular configuration should be made a part of the "guidelines" proposed by NBS. While the configuration looks good on paper, it may be difficult to understand and/or enforce in the field. If included in Standard Practice the 3 ft max bank should be retained.
13	(b)(4)(i)b.	See the first four lines at the top of page 13. Table 2 is necessary in Standard Practice only if Fig. 3(b) is retained. Moving the option shown as Fig. 3(b) to the Guidelines removes the need for Table 2 which is confusing and also removes the need for special tables and figures outlining the placement of shoring in the lower part of the ditch.
13	(b)(4)(i)c.	For Standard Practice it may be worthwhile to include all surcharges, including allowances for heavy equipment, in the adjusted depth. The Task Force recommended a minimum of 300 pounds per square foot for surcharge. Dr. Yokel has greatly simplified Table 3 but it still can be confusing. Moving Table 3 to the Guidelines and greatly increasing the surcharges to allow for heavy equipment may lead to "overdesigned" shoring and shields, but Standard Practice would thereby be greatly simplified.
13	(ii)b.	The Task Force recommended a 500 lb gravity load.
13	(ii)c.	This statement is not clear. Does this mean a 240 ft-lb impact load per square foot? The entire (ii)c. should become a part of the Guidelines and removed from Standard Practice.
13	(ii)	This entire section devoted to the required strength of shoring systems, trench shields and trench boxes needs to be moved to the Guidelines.
16	b.	If some of the previous suggestions are followed, hydraulic shores and other assemblies can be brought into Standard Practice. At a meeting in October, 1980 with NBS and members of the hydraulic shoring industry it was agreed that reasonably simple charts for the selection of shores can be developed. This seems to be in keeping with Cass' (6) recommendations for depth to 14 or 15 ft. There is no question that the resulting system would be greatly over-designed

Page	Location	Comment
		at times, but the freedom to use Standard Practice for most work (2) and thereby not requiring the services of an engineer seems to outweigh the disadvantages of overdesign.
16	c.	Timber shoring is properly located in the Guidelines; selection must be by an engineer. The Guidelines are for the use of licensed professionals.
16	(5)(ii) last two lines	The statement in parentheses is a vague performance specification which detracts from a well stated, precise paragraph.
16	(5)(iii)	Excavation below the bottom of the protective element has merit; exactly how much to allow is difficult to determine. Certainly engineers can design specific protection for unique circumstances, the Guidelines will help, but permitting excavation below the protection device in Standard Practice will require very careful consideration.
18	(a)	"...with standards required by a <del>registered-architect</del> , a registered professional engineer, or other duly licensed <del>or-recognized</del> authority. ..."
19	(m)	Twenty-four hours for short term seems most reasonable.
19	(o)	Negotiable slope needs to be specified; 1½:1 seems reasonable.
19	(p)	How is a qualified person to be identified? Unless there is a specific procedure anyone can claim to be a qualified person. No objection if the qualified person is permitted to use Standard Practice only.
19	(t)	same argument; use 24 hours for short term.
19	(aa)	<u>Stable Slope</u> . A meaningless term unless it is arrived at by a licensed engineer. This term has no place in Standard Practice!
20	(gg)	Working loads are best relegated to the Guidelines where they can be dealt with by an engineer.

# DRAFT

## Summary

There must be clear separation between Standard Practice and cases where an engineer has certified the procedure to be followed.

It is recommended that Standard Practice be permitted to a depth of cut of 15 feet; this includes most excavation and trenching work. At depths greater than 15 feet, or for special work, the engineer must assume full responsibility for the design of the protective system. The 15 ft. depth needs verified.

Standard Practice must be written such that the protective measures resulting from the application of Standard Practice are observable, measurable, understandable by all parties (with application of the regulations) and provide for the safety and health of the worker. It is recognized that Standard Practice may at times result in substantial overdesign, but this would not be new to the construction field.

It is anticipated that competent or qualified persons working for the contractor would select methods within Standard Practice to protect workers, but that any deviation from Standard Practice would need to be designed by an engineer. The engineer is recognizable by a professional license.

Several items which need consideration: construction right of way requirements, toxic materials, safety program as an item in the bid document, soil conditions and utilities in the bid document and better safety education for all. The Task Force final report lists other concerns.

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**RECOMMENDATIONS**

1. Use Standard Practice to a depth of 15 feet.
2. Over 15 feet or where Standard Practice is changed an engineer must assume full responsibility.
3. Standard Practice must be observable, measurable and understandable by all parties and above all must be effective.
4. Competent and qualified persons working for the contractor would select methods within Standard Practice but an engineer would be required where deviations occur.
5. Construction right-of-way needs to be considered.
6. Toxic materials need to be considered.
7. A safety program needs to be outlined in the bid documents.
8. Soil conditions and utilities need to be considered in the bid documents.
9. Safety education is a must for all.

(9b)



**DRAFT**

**References**

1. Building and Construction Trades Department AFL - CIO. Trenching Hazard Identification Task Force; Final Report. Prepared for the National Bureau of Standards; Building Safety Section; James O. Bryson, Chief. April, 1977.
2. Hinze, Jimmie and Nicholas J. Carino. A Study of Work Practices Employed to Protect Workers in Trenches; NBSIR 80-1988. National Bureau of Standards. March 1980.
3. Salomone, Lawrence A. and Felix Y. Yokel. Proceedings, Federal Workshop on Excavation Safety, September 19 and 20, 1978. National Bureau of Standards. July, 1979.
4. Yokel, Felix Y., Riley M. Chung and Ronald L. Stanevich. New Concepts for Construction Practice Standards for Excavations. Concrete Pipe News; pages 28-33, vol 33 no 2, April, 1981.
5. Thompson, Louis J. and Ronald J. Tanenbaum. Excavations, Trenching & Shoring: the responsibility for design and safety. Sponsored by the Associated General Contractors of America. A report of the Texas A & M Research Foundation. College Station Texas. September, 1975.
6. Cass, W. Martin "Red". Common Sense in the Common Trench. Equipment Guide-Book Company; 2800 West Bayshore Road, Palo Alto, California 94303. 1979.

**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Amend the definition of Excavation, Trenches, Earthwork in Section 1584 to read:

**Excavation, Trenches, Earthwork.**

(A) **Bell Hole.** An additional excavation made into the sides or bottom of a trench to provide additional work space.

(B) **Bellad Excavation.** A part of a shaft or footing excavation, usually near the bottom and bell-shaped, that makes the cross-sectional area at that point larger than that above.

(C) **Braces for Excavations.** The horizontal members of the shoring system whose ends bear against the uprights or stringers.

(D) **Earthwork.** The process of excavating, moving, storing, placing, and working any type of earth materials.

(E) **Excavation.** A man-made cavity or depression in the earth's surface, including its sides, walls, or faces formed by earth removal and producing unsupported earth conditions by reason of the excavation. If installed forms or similar structures reduce the depth to width relationship, an excavation may become a trench.

(F) **Hard Compact.** All earth material not classified as running. ~~or-unstable~~

(G) **Qualified Person.** A person designated by the employer who by reason of experience or instruction is familiar with the operation to be performed and the hazards involved.

(H) **Running.** Earth material whose angle of repose is approximately zero, as in the case of soil in a nearly liquid state, or dry, unpacked sand which flows freely under slight pressure. Running material also includes loose or disturbed earth that can only be contained with solid sheeting.

(I) **Shaft.** An excavation under earth's surface whose depth, either horizontal or vertical, is much greater than its cross-sectional dimensions such as those formed to serve as wells, cesspools, certain foundation footings, and under streets, railroads, buildings, etc.

## STANDARDS PRESENTATION

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### CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

(J) Sheet Pile. A pile, or sheeting, that may form one of a continuous interlocking line, or a row of timber, concrete, or steel piles, driven in close contact to provide a tight wall to resist the lateral pressure of water, adjacent earth, or other materials.

(K) Shore (Strut). A supporting member that resists a compressive force imposed by a load.

( ) Shoring System. A temporary structure for the support of earth surfaces formed as a result of excavation work.

(M) Sides, Walls, and Faces. The vertical or inclined earth surfaces formed as a result of excavation work.

(N) Sloping of Earth. The angle with the horizontal which a particular earth material will stand indefinitely without movement. A method of excavation whereby the faces of an excavation or trench are laid back to provide protection from moving ground.

(O) Spoil. The earth material that is removed in the formation of an excavation.

(P) Stringers. The horizontal members of the shoring system whose sides bear against the uprights or earth.

(Q) Trench. Shall mean an excavation in which the depth exceeds the average width of its cross section. Excavations that are more than 15 feet wide at the bottom, shafts, tunnels, and mine excavations are not trenches. A narrow excavation made below the surface of the ground. In general, the depth is greater than the width at the bottom, but the width of a trench at the bottom is not greater than 15 feet.

(R) Trench Jack. Screw or hydraulic type jacks used as cross bracing in a trench shoring system.

? (S) Trench Shield. A shoring system generally composed of steel plates and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom of which can be moved along as work progresses. ND

(P) -- Unstable, as used in Article 6, -- Earth material other than running that, because of its nature or the influence of related conditions, cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.

(T) Uprights. The vertical members of the shoring system.

(U) Waler. A structural member in a horizontal or nearly horizontal position used for stiffening or securing other components of concrete forms, excavation sheeting, or similar temporary structures.

CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Adopt new Section 1540 to read:

1540. Excavations.

• (a) Scope. Sections 1540(b) through (n) and 1541 apply to all excavations, trenches, shafts or earthwork and establish essential requirements and minimum standards of safety in earth excavation work.

NOTE: (1) Whenever the term "excavation(s)" is used it also applies to trenches, shafts and other earthwork.

(2) For additional shaft and incline excavation details, see Sections 1542 and 1543.

(3) For additional earthwork excavation details, see Sections 1544 through 1547 which apply to such work locations as borrow pits, road or dam construction sites and similar work areas.

(4) The Orders in this Article do not apply to work covered by the Mine Safety Orders or the Tunnel Safety Orders.

(b) Preparations.

(1) Prior to opening an excavation, the employer shall determine whether underground installations such as, sewer, water, fuel, electric lines, telecommunication lines, etc., will be encountered, and if so, where such underground installations are located.

(2) When the excavation work approaches the approximate crossing or parallel location of such an underground installation and danger of accidental contact or disturbance is possible, the exact location shall be determined by appropriate means before proceeding. When it is uncovered, adequate protection shall be provided for the existing installation.

(3) All known owners of underground facilities in the area involved shall be advised of proposed work at least 48 working hours prior to the start of excavation work.

Exception: Emergency repair work to underground facilities.

(4) Trees, boulders, poles and other surface encumbrances located so as to create a hazard to employees involved in excavation work, or in the vicinity thereof at any time during operations, shall be removed or made safe before excavating is begun.

CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD(c) Exposure.

(1) No employer shall cause or permit his employees to work in or adjacent to any excavation until a reasonable examination of same has been made by a qualified person to determine that no recognizable conditions exist exposing them to injury from possible moving ground.

(2) Excavations shall be inspected by a qualified person after every rainstorm or other hazard-increasing occurrence and the protection against slides and cave-ins shall be increased, if necessary, before employees are permitted to enter the excavation.

(d) Protection. Employees who must enter excavations 5 feet or more in depth shall be protected by a system of shoring, sloping of the ground, benching, or other effective means as provided by these Orders. Protection for employees who must work in excavations less than 5 feet in depth shall also be provided when examination by a qualified person indicates that hazardous ground movement may be expected.

(e) Spoil.

(1) Excavated material shall be prevented from falling back into the area where employees are working. This shall be done by locating the spoil at a distance from the edge of the excavation consistent with the character of the material and the nature of the operations, but unless otherwise contained, in no case shall be excavated material be placed closer than 2 feet from the edge of excavations.

(2) No method that disturbs the soil that is in place (such as driving stakes) shall be used to contain the spoil material.

(f) Supervision. Excavation work and work in an excavation shall at all times be under the immediate supervision of someone with authority and qualifications to modify the shoring, sloping or other system or work methods as necessary to provide greater safety. Such modification shall not permit the specific dimension requirements of other Orders to be less restrictive than shown except as permitted by Section 1541(a)(6). This person shall examine the material under excavation and improve the shoring or other methods beyond the minimum requirements, as necessary, to insure protection of workers from moving ground.

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

(g) Access.*or NEARBY  
SLOPE, (FED. MAP)*

(1) A convenient and safe means of access shall be provided for employees to enter and leave an excavated area. This shall consist of a stairway, ladder or ramp securely fastened in place at suitably guarded or protected locations where employees are working.

(2) When employees are required to be in trenches 4 feet or more in depth, a safe means of access shall be provided and located so as to require no more than 25 feet of lateral travel.

Exception: In utility trenches less than 5 feet in depth, earth ramps or steps are acceptable provided that they are not more than 75 feet on centers.

(h) Crossings.

(1) Trenches shall be crossed only where safe crossings have been provided.

(2) When walkways or bridges are provided across excavated areas, they shall be provided with standard guardrails and toeboards when the depth of excavation exceeds 7-1/2 feet.

(i) Excavators. An employee working in the vicinity of operating excavating equipment shall be required to work in a safe position such that the employee is not in danger of falling into or otherwise contacting the machine's moving parts.

(j) Undermining.

(1) No excavation work shall take place below the level of the base of an adjacent foundation, retaining wall or other structure until it has been determined by a qualified person that such excavation will in no way create a hazard to workers or until adequate safety measures have been taken for the protection of workers.

(2) Undermined sidewalks and/or pavements shall be supported to safely carry all anticipated loads.

(3) If the stability of adjoining buildings or walls is endangered by excavations, either shoring, bracing, underpinning, or other method affording equivalent protection for workers shall be provided as necessary to ensure their safety. All such systems shall be inspected daily or more often, as conditions warrant, by a qualified person and the protection effectively maintained.

CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD(k) Retaining Walls.

(1) No existing wall or other structure shall be made by reason of an excavation or backfill, to function as a retaining wall until it has been determined that such wall will safely withstand all expected loads that otherwise might be a source of hazard to workers.

(2) Wherever a permanent retaining wall, in lieu of the temporary shoring system of this Article, is constructed to hold any part of an excavation that might endanger workers, such wall shall be designed and constructed to effectively resist all existing and expected loads. Standards of design shall be comparable to those of the California Administrative Code, Title 24, Building Standards, or any comparable local building code of equal or greater restrictiveness.

(l) Barriers at Unattended Work Locations.

(1) Means shall be provided to prevent mobile equipment from inadvertently entering excavations.

(2) Adequate physical barrier protection shall be provided to prevent employees from falling into excavations.

(A) All wells, pits, shafts, caissons, etc., shall be barricaded or securely covered.

(B) Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc., shall be backfilled.

(m) Water Accumulation.

(1) Diversion ditches, dikes, or other effective means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation.

(2) Accumulations of water in excavations which endanger the stability of those excavations or pose a hazard to employees shall be controlled before further work progresses.

(n) Vibrations or Superimposed Loads. Special safety provisions consisting of additional bracing or other effective means shall be taken at excavations adjacent to streets, railroads, or sources of external vibrations or superimposed loads. Similar provisions shall be taken in excavations made in areas that have been previously filled.

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Adopt new Section 1541 to read:

1541. Shoring, Sloping and Benching Systems.

(a) General.

(1) All materials of the shoring system used in complying with the provisions of this Article shall be free from defects and damage that might in any way impair their protection function.

(2) Where a shoring system is used it shall be designed and installed to sustain all existing and expected loads.

(3) Provisions shall be made by the employer to prevent injury to employees engaged in the installation of shoring for trenches and other excavations. In trench work this may be done by providing and requiring the use of devices that will allow upper cross braces to be placed from the ground surface before employees work in the trench at those points. In deep trenches requiring additional braces, workers shall then progress downward, protected by cross braces that have already been set firmly in place. The reverse procedure shall be followed when removing shoring.

(4) No part of the shoring system of any excavation shall be removed until effective means have been taken to avoid hazards to employees from moving ground.

(5) If a newly installed masonry or concrete wall is to be depended upon for protection against moving ground, it shall have attained adequate strength to sustain resulting pressures before employees are permitted to enter.

(6) If the excavation is deeper than 20 feet or an alternate shoring, sloping or benching system or combination thereof is to be used, a civil engineer, currently registered in California, shall prepare detailed plans showing the materials and methods to be used. See Appendix Plate C-22. ✓

Exception: Sloping or benching as permitted by this Article.

(A) Where alternate shoring, sloping, or benching systems are used, the engineer's detailed plans shall be available for inspection by the Division at the work site.

(B) Employees must be adequately trained in the safety precautions and hazards associated with the alternate shoring, sloping, or benching systems used.

(C) The written Code of Safe Practices required by Section 1509 shall be revised as appropriate to incorporate the engineer's recommendations.

(b) Standard Shoring System - General.

(1) Shoring shall be installed in accordance with Tables 1 or 2 of these Orders or as detailed in plans and specifications prepared by a civil engineer currently registered in California. See Appendix Plate C-22 for engineering criteria.



CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

(2) Solid wood sheeting or wood sheet-piling shall be not less than 2-inches in thickness. However, plywood 1 1/8-inch in thickness may be substituted.

(3) Wood uprights shall be not less than 2 inches by 8 inches.

(4) Wood braces and diagonal shores (struts) shall not be less than 4-inch by 4-inch material and not subjected to compressive stress in excess of values given by the following formula:

$$S = 1300 - (20L/D)$$

Maximum Ratio (L/D = 50)

Where L = length, unsupported, in inches  
and D = least side of the timber in inches  
S = allowable stress in pounds per  
square inch of cross section.

(5) Diagonal shores (struts) shall be wedged or cleated at the bulkhead end, and, if bearing on the ground, shall not impose loads in excess of test-determined soil-bearing values, or in the absence of test data, those given in Plate C-22 of the Appendix.

NOTE: Allowance should be made for the horizontal component of force.

(6) Diagonal shores (struts) shall not be placed at an angle greater than 45 degrees with the horizontal.

(7) When tie rods are used to restrain the top of sheeting or other retaining systems, the rods shall be securely anchored.

(8) When tight sheeting or sheet-piling is used, full loading due to ground water table shall be assumed, unless prevented by weep holes, drains or other means.

(9) Additional stringers, ties, and bracing shall be provided to allow for any necessary temporary removal of individual supports.

(10) If nonstress grade lumber is used for sheeting and lagging, the following thickness and spacing requirements shall be observed:

Minimum rough thickness  
of sheeting or lagging

2 inches  
3 inches

Maximum spacing  
of shoring

4 feet  
7 feet

(11) All hydraulic shoring systems shall be installed, tested and maintained in accordance with the manufacturers' recommendations or in accordance with good engineering practice.

**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD****(c) Trench Shoring Systems.**

(1) Trench shoring systems shall be installed in compliance with Section 1541(b) and Tables 1 and 2 of this section.

(2) Shoring systems in trenches shall consist of uprights held rigidly opposite each other against the trench walls by jacks or horizontal cross members (braces) and, if required, longitudinal members (stringers/walers) as required in Tables 1 and 2.

(3) Uprights shall be installed parallel with each other.

(4) A shored trench shall not be sloped in excess of 15 degrees from vertical.

(5) Uprights shall not be less than 2 inches in nominal thickness.

Exception: Plywood panels at least 3/4-inch thick may be used behind the uprights in order to hold loose material not likely to impose heavy loads.

(6) Uprights shall extend to at least the top of the trench and to as near the bottom as permitted by the material being installed, but not more than 2 feet from the bottom.

Exception: When running soil is encountered, shoring shall extend to the bottom.

(7) Cross braces shall consist of metal screw-type trench jacks with a foot or base on each end of pipe, or timbers placed horizontally and bearing firmly against uprights or stringers. Hydraulic metal braces may also be used. See Tables 1 and 2.

(8) The minimum number of horizontal braces, either jacks or timbers, required for each pair of uprights shall be determined by the number of 4-foot zones into which the depth of the trench may be divided. One horizontal brace shall be required for each of these zones, but in no case shall there be less than 2 braces. Trenches, the depths of which cannot be divided equally into these standard zones, shall have an extra horizontal brace supplied for the short remaining zone, if such zone is greater than 1/2 the 4-foot unit. In no case, however, shall the vertical spacing of horizontal braces be spaced greater than 4 feet center to center. Minor temporary shifting of horizontal bracing will be permitted when necessary for the lowering of materials into place.

(9) The dimensions and spacing of the elements of the shoring system shall be governed by the depth of the trench, type of soil encountered, and other special conditions of the site, but in no case shall they provide less strength than the members listed in the following tables which are to be considered as a minimum requirement.

TABLE 1  
SHORING FOR HARD COMPACT SOIL

Span (ft)	Uprights		Beams							Stringers (Walers)	
	Horizontal Spacing (ft)	Size (in)	Horizontal Spacing (ft)	Wood		Aluminum Pipe and Hydraulic Systems		Steel Pipe and Hydraulic Systems		Vertical Spacing (ft)	Wood Size (in)
				Size (in)	Max. Trench Width (ft)	Min. Dia. (in)	Max. Trench Width (ft)	Min. Dia. (in)	Max. Trench Width (ft)		
0 to 7	0	3x8	0	4x4	0	2 1/2	0	1 1/2	3	None	--
	4	3x10	4	4x4	0	2 1/2	0	1 1/2	3	0	4x4
	2	2x8	2	4x4	0	2 1/2	0	1 1/2	2	0	4x4
7 to 10	0	4x10	0	4x4	0	2 1/2	6	2	6	None	--
	4	3x10	4	4x4	11	3	10	2 1/2	12	4	6x8
	2	3x10	2	4x4	11	3	10	2	15	0	6x8
10 to 12	0	4x12	0	4x4	6	2 1/2	6	2	8	None	--
				6x6	15	3	0	2 1/2	12		
	4	3x12	4	4x4	8	2 1/2	9	2	10	4	8x10
				6x6	15	3	10	2 1/2	11		
	2	3x8	2	4x4	10	2 1/2	10	2 1/2	13	4	8x10
				6x6	15	3	10	2	15		
12 to 15	0	6x8	0	4x4	2	2 1/2	5	2	6	None	--
				6x6	15	3	0	2 1/2	10		
	4	4x10	4	4x4	4	2 1/2	6	2	8	4	8x10
				6x6	15	3	10	2 1/2	12		
	2	3x10	2	4x4	4	2 1/2	10	2 1/2	13	4	8x10
				6x6	15	3	10	2	15		
15 to 20	0	6x10	0	6x6	0	2 1/2	3	2 1/2	0	None	--
				8x8	15	3	0	2	12		
	4	6x8	4	6x6	10	2 1/2	6	2 1/2	10	4	8x10
				8x8	15	3	9	2	15		
	2	4x10	2	6x6	12	2 1/2	8	2 1/2	12	4	8x12
				8x8	15	2 1/2	10	2	15		

TABLE 2  
SHOWING FOR BURNING SOIL

219

H	Uprights		Bridges						Streets (Walls)		
	Horizontal Spacing (ft)	Thickness (in)	Horizontal Spacing (ft)	Size (in)	Wood Max. Trench Width (ft)	Aluminum Pipe and Hydraulic System Min. Dia. (in)	Aluminum Pipe and Hydraulic System Max. Trench Width (ft)	Steel Pipe and Hydraulic System Min. Dia. (in)	Steel Pipe and Hydraulic System Max. Trench Width (ft)	Vehicle Spacing (ft)	Wood Size (in)
0	60114	2	6	4x4 4x6	0 10	24 3	0 10	24 2	3 6	4	0x8
0 to 10	60114	3	6	4x6 0x8	0 15	24 3	0 0	24 24	6 12	4	0x10
0 to 12	60114	3	4	4x6 0x8	0 15	24 3	0 0	24 24	6 10	4	10x10
0 to 15	60114	3	4	4x6 0x8	0 15	24 3	0 0	24 3	8 15	4	10x12
0 to 20	60114	4	4	0x8 0x10 10x10	10 15 20	3 34 4	0 0 10	24 3 24	6 12 15	4	12x12

**GENERAL NOTES**

1. Metal pipe braces permitted by these Orders shall be Schedule 40, or equivalent, and installation shall be as required by these Orders.
2. Lumber to be "Selected Lumber" quality. (See Definitions - Section 1504.)
3. The braces specified in Tables 1 and 2 apply only to trenches as defined in these Orders.
4. Timber members of equivalent "Section Modulus" (required) may be substituted for uprights and stringers.
5. In lieu of the above metal shoring systems, the use of properly maintained hydraulic metal shoring units with equivalent strength is acceptable.

GENERAL NOTES

1. Metal pipe bridges permitted by these Orders shall be Schedule 40, or equivalent, and installation shall be as required by these Orders.
2. Timber to be "Selected Lumber" quality, (See Definitions - Section 1504).
3. The bridges specified in Tables 1 and 2 apply only to trenches as defined in these Orders.
4. Timber members of equivalent "Section Modulus" (required) may be substituted for uprights and stringers.
5. In lieu of the above metal shoring systems, the use of properly maintained hydraulic metal shoring units with equivalent strength is acceptable.

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best available copy.

CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD(d) Protective Shields and Welding Huts.

(1) If protective shields or welding huts are used to protect workers, they shall be constructed of steel or other material that will provide protection at least equivalent to that afforded by the materials specified in Tables 1 and 2.

(2) Plans and calculations prepared by a civil engineer currently registered in California shall be made available for field inspection at the site where the shield or welding hut is used.

(e) Bell or Pot Holes.

(1) Bell (or pot) holes shall provide adequate clearance for the work to be done, and shall be supported by shoring and bracing as required by these Orders for trenches unless protective shields or welding huts are used.

(2) If the operation performed in the bell (or pot) hole requires that an employee use welding equipment from a reclined position on the bottom, the bell (or pot) hole excavation shall be of such shape that the employee will have adequate space for the performance of this operation without removing any of the required shoring system.

(f) Sloping or Benching Systems. In lieu of a shoring system, the sides or walls of an excavation or trench may be sloped or benched, provided equivalent protection is thus afforded. Where sloping is a substitute for shoring that would otherwise be needed, it shall be  $\frac{3}{4}$  horizontal to 1 vertical except where the instability of material requires a slope greater than  $\frac{3}{4}$  to 1.



flatter than  
 $\frac{3}{4}$  to 1

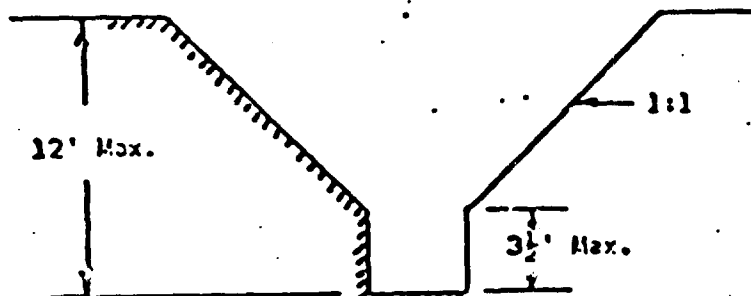
## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Exceptions:

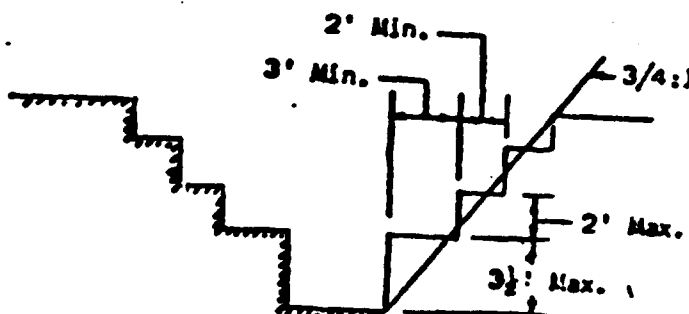
(1) In hard, compact soil where the depth of the excavation or trench is 8 feet or less, a vertical cut of 3 1/2 feet with sloping of 3/4 horizontal to 1 vertical is permitted.



(2) In hard, compact soil where the depth the excavation or trench is 12 feet or less, a vertical cut of 3 1/2 feet with sloping of 1 horizontal to 1 vertical is permitted.



(3) In hard, compact soil, benching is permitted provided that a slope ratio of 3/4 horizontal to 1 vertical, or flatter, is used.



**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Amend Section 1542 to read:

**1542. Shafts.**

**(a) General.**

(1) All wells or shafts over 5 feet in depth into which employees are permitted to enter shall be retained with lagging, ~~spilling~~ ~~spilling~~, or casing.

(2) The lagging, ~~spilling~~ or casing shall extend at least one foot above ground level and shall be provided the full depth of the shaft or at least five feet into solid rock if possible.

NOTE: See pertinent portions of Section 1548 for additional requirements relating to wells and shafts.

(b) Small Shafts Dry-Cemented Hard- Compact Ground. Two-inch (nominal) cribbing may be used in square shafts not over 4 feet square in dry-cemented hard compact ground. Each member shall be cut 1/2 way through the width of the member and dovetailed into position so each member will act as a shore as well as lagging. Strips shall be nailed in each corner to prevent the boards from dropping down.

**(c) Shafts in Other Than Dry-Cemented Hard- Compact Ground.**

(1) A system of lagging supported by braces and corner posts shall be used for square or rectangular shafts. Corner posts of 4-inch by 4-inch material are normally acceptable in shafts 4 feet square, or smaller, if they are braced in each direction with horizontal 4-inch by 4-inch members at intervals not exceeding 4 feet. Braces and corner posts in larger shafts shall be correspondingly larger.

(2) Round shafts shall be completely lagged with 2-inch material which is supported at intervals not greater than 4 feet by means of adjustable rings of metal or timber that are designed to resist the collapsing force, or cased in a manner that provides equivalent protection. Means-shall-be-provided-to-hold-rings-and lagging-in-place.

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

~~(d) -- Shafts over 150 feet in depth shall have a manway partitioned off with 2-inch material or equivalent and shall have a ladderway with railed platforms every 30 feet.~~

~~(e) Belled Excavation. No workman shall be required or permitted to enter any well or shaft, particularly those drilled for foundation footings, for the purpose of enlarging the bottom by hand or similar work, unless the walls of the shaft are supported as described in these Orders, or unless a casing affording equivalent protection is in service. The belled section of any additional shaft excavation in which men work shall also have equivalent bracing if the shaft casing does not provide protection. The shaft casing or shoring is not acceptable for belled excavation protection where the height of the bell exceeds 4 feet or its horizontal dimension extends 3 feet or more beyond the shaft wall line. Additionally, men entering such shafts shall wear a body harness securely fastened to a line individually manned and separated from any line used to remove materials from the excavation.~~

~~Note: Refer to Section 1532 for requirements prior to entering confined spaces.~~

~~History: 1. Amendment of subsection (e) filed 5-21-75, effective thirtieth day thereafter (Register 75, No. 21).~~

(d) Bell Excavations. Provisions for the protection of workers that are engaged in bellling or enlarging the bottoms of shafts by hand shall include at least the following elements:

- (1) Sufficient physical protection from potential ground movement or collapse.
- (2) Adequate mechanical ventilation.
- (3) A line, suitable for instant rescue, securely fastened to a shoulder harness and worn by each employee entering the shaft(s).
- (4) A properly equipped hoist and platform for hoisting or lowering workers in shafts over 50 feet in depth.
- (5) Barriers that prevent materials from falling into the shaft(s).



**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Amend Subsections (a), (d) and (u) of Section 1544 to read:

**1544. Earthwork and Excavating.**

**NOTE: See pertinent portions of Section 1540 for additional requirements relating to earthwork and excavating.**

(a) Whenever the Division considers that the height and condition of the face constitutes a serious hazard to employees, it shall require the installation of a bench or other suitable method of working shall be required.

(b) When a bench or multiple-bench method of operation is required, a setback of at least  $\frac{1}{4}$  the height of the single face or bank for each section of the face or bank shall be required.

(c) When determining the maximum permitted slope of the face, consideration shall be given to:

- (1) Nature of the material being excavated.
- (2) Extent to which the material is cemented or consolidated.
- (3) Height of the face.
- (4) Type and size of equipment used at the face and amount of protection this equipment affords the operator.
- (5) Safety of employees who are not protected by such equipment.

(d) Where the face is composed of loose or unstable materials, the slope of the face shall not exceed  $\frac{3}{4}$  horizontal to 1 vertical where the height is greater than that which can be reached by the dipper or bucket of the excavator or loader being used.

(e) Where the face is composed of moderately compacted materials that are not firmly cemented or consolidated but which experience indicates will stand well in place, the slope shall not exceed  $\frac{1}{2}$  horizontal to 1 vertical where the height is greater than can be reached by the dipper or bucket of the excavator or loader being used.

Amend Subsection (a) of Section 1545 to read:

**1545. Overburden.**

(a) No person shall be permitted under a face or bank where stripping or other similar operations constitute a hazard.

**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

**Amend Subsections (a), (d) and (e) of Section 1546 to read:**

**1546. Face Inspection and Control.**

(a) A daily physical inspection shall be made of faces and banks, including the tops, where men employees are exposed to falling or rolling materials. The inspection shall be made by a competent-man qualified person who shall dislodge or make safe any material dangerous to employees, or shall cause such material to be dislodged or made safe.

(b) No person shall be permitted to work near a face made unsafe by primary blasting, rains, freezing or thawing weather, or earthquakes until the face has been inspected and made safe.

(c) Overhanging banks are forbidden, except:

(1) Where material is moved away from the face by mechanical equipment having controls located at a safe distance so that no employee is required to approach the face in the course of normal operation.

(2) Where the bank is undercut with a stream of water and the monitor is located at a safe distance from the bank.

(d) Where necessary, a-competent-trained an employee shall be employed at the face, and instructed to give warning when loose rock or other materials are about to fall.

(1) The employee shall be provided with a whistle, siren, or other devices that will give adequate warning to employees.

(2) The employee shall have no other work to distract his attention from his duties as defined above.

(e) When working at night, sufficient illumination shall be provided throughout the working area so that movement of men employees and equipment can be readily observed.

**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

Amend Section 1547 to read:

**1547. Protection of Workers at the Face.**

(a) No work shall be permitted above or below ~~men~~ employees at the face if such work endangers their safety.

(b) Workers at the face shall be protected as follows:

(1) On top of the bank, by fencing with guardrails or ropes; by using railed platform; or by using safety belts and life lines. This does not apply where the bank is less than 20 feet high or the slope below is less than 3/4 horizontal to 1 vertical or where no work is performed within 10 feet of the edge.

(2) On the face, by removing loose rock from over the working place and by the use of safety belts and life lines, portable staging, boatswain's chair or skips especially designed for use at faces. If a boatswain's chair is used, the employee shall be attached thereto with a safety belt and life line equipped with an approved effective descent control device.

~~When-necessary-for-safety,~~ 2 Two or more persons shall be employed in cooperation with each other in drilling, blasting, or removing loose rock.

Life lines used for scaling or inspection shall be protected from excessive fraying or damage ~~or~~ and shall have a wire center rope.

(3) At the foot of the bank by removing loose rock from above the working place, and maintaining a ready way of exit to a place of safety.

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Amend Appendix Plate C-22 to read:

PLATE C-22  
BEARING VALUE OF SOIL

Shores and similar members that depend upon earth for support will probably require foot blocks or sills to distribute the load. In the absence of test data that establish the sustaining power of the soils in question, the following information should be helpful in determining the size of ~~fill~~ sill needed to assure adequate support from the soil

Soil type	Tons allowable per square foot
Soft clay -----	1
Wet clay -----	2
Sand and clay, mixed in layers -----	2
Fine dry sand -----	3
Hard dry clay -----	4
Coarse compact dry sand -----	4

DESIGN CONSIDERATIONS  
EXCAVATIONS, SLOPES AND BENCHES

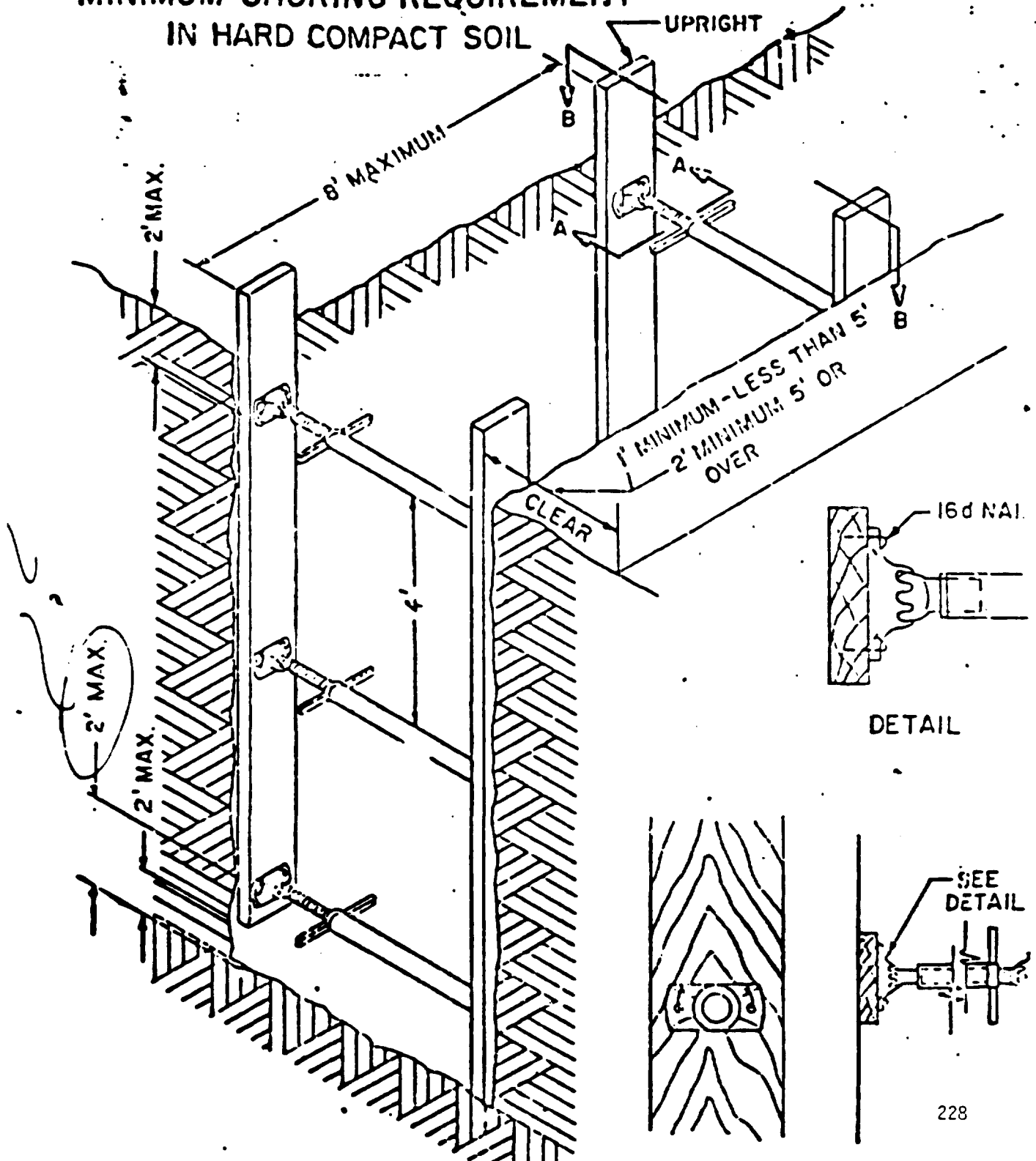
The determination of the slope or bench configuration or design of the shoring system shall be based upon careful evaluation of such pertinent factors as the following:

- (1) Depth and width of cut.
- (2) Possible variation in water content of the material while the excavation is open.
- (3) Anticipated changes in materials from exposure to air, sun, water or freezing temperatures.
- (4) Loading imposed by structures, equipment, overlaying material or stored material.
- (5) Vibration from equipment, blasting, traffic, trains or other sources.
- (6) Existing underground facilities.
- (7) New or old adjacent excavations.
- (8) A minimum coefficient of active earth pressure of 35 pcf (Kw-35) shall be used in all calculations unless a soils evaluation indicates otherwise.

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Adapt new Appendix Plate C-24-a to read:

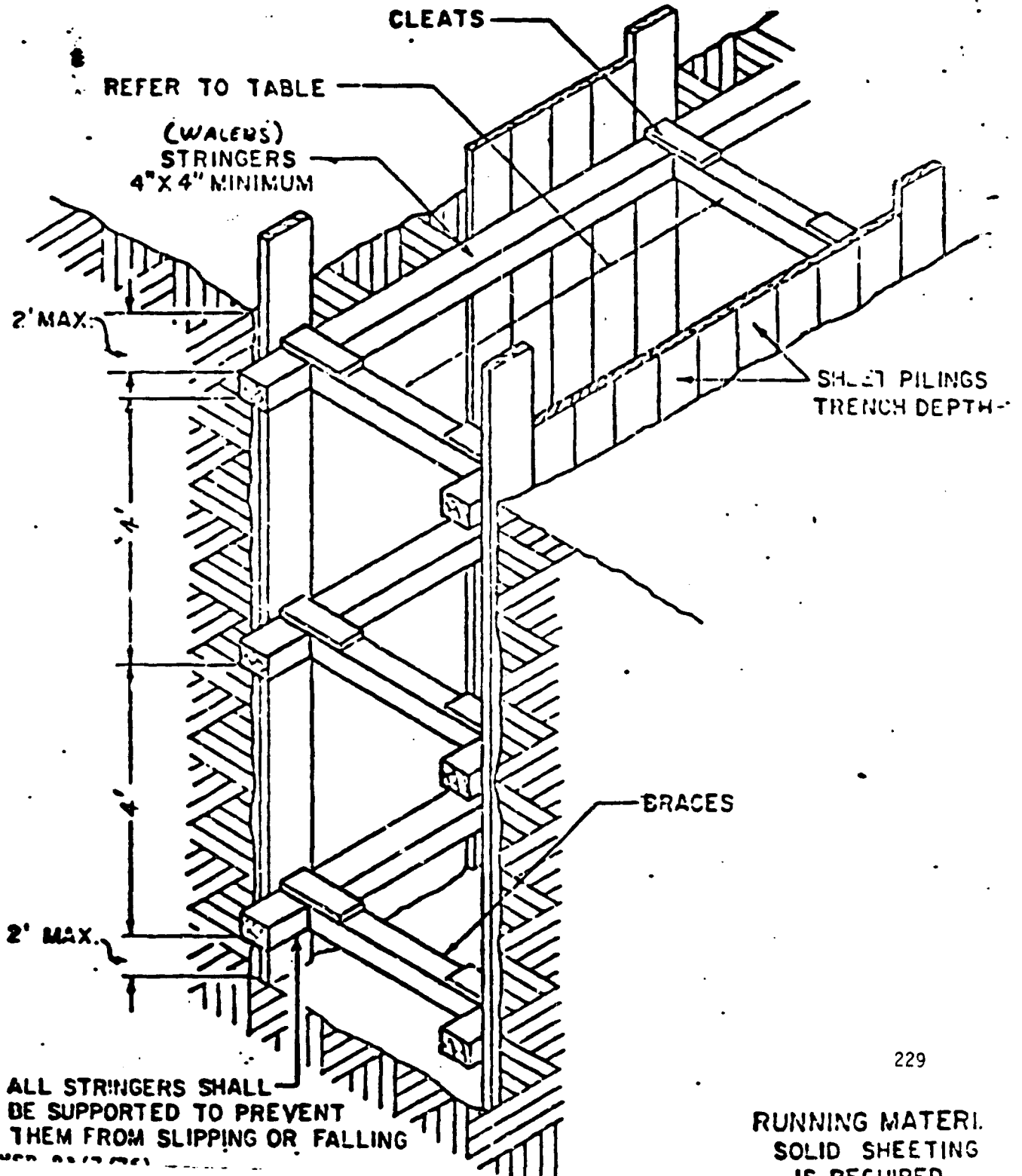
Plate C-24-a

MINIMUM SHORING REQUIREMENT  
IN HARD COMPACT SOIL

## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Adopt new Appendix Plate C-24-b to read:  
 Plate C-24-b

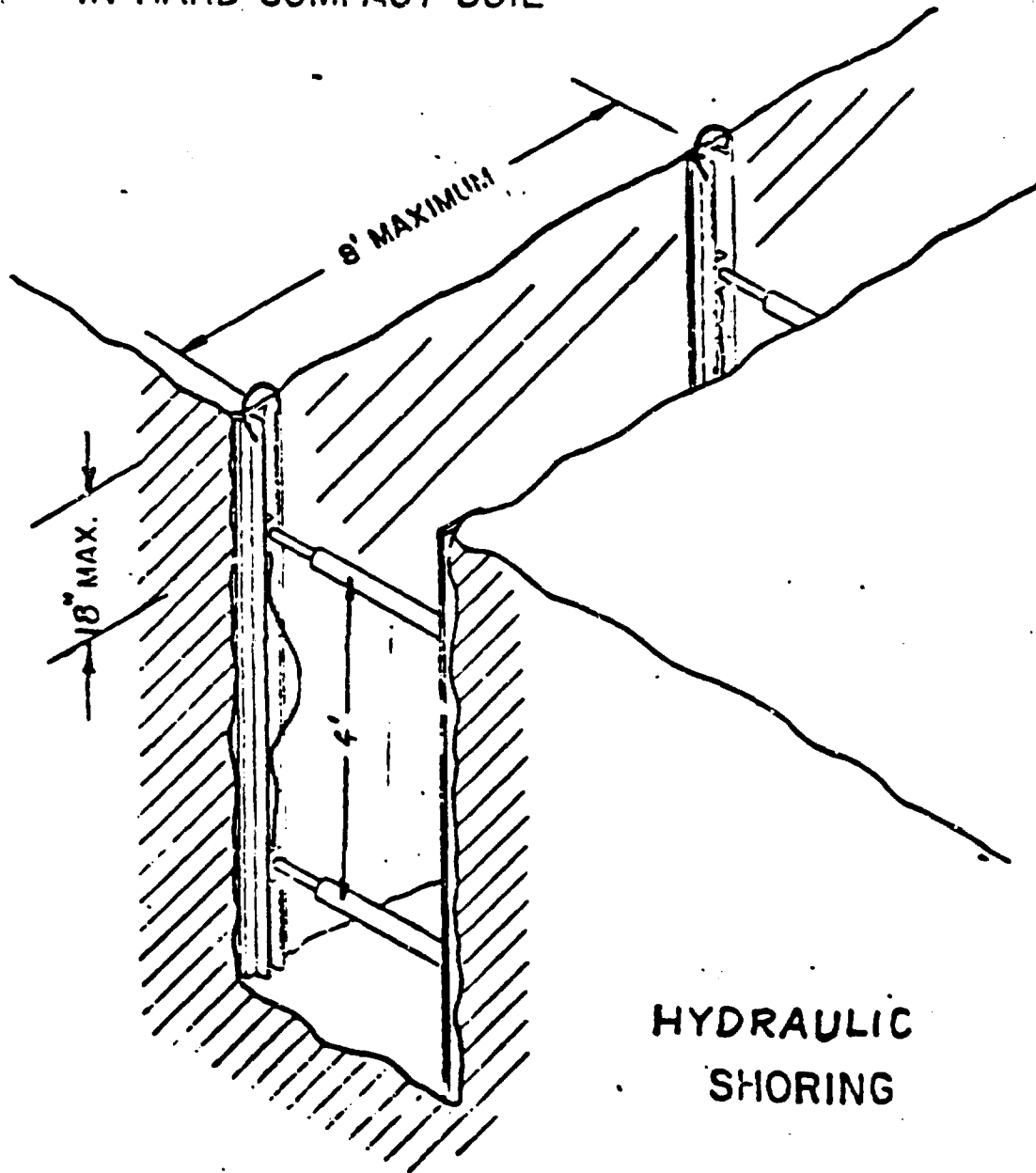
# CLOSE SHEETING METHOD IN RUNNING SOIL



## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Adopt new Appendix Plate C-24-c to read:

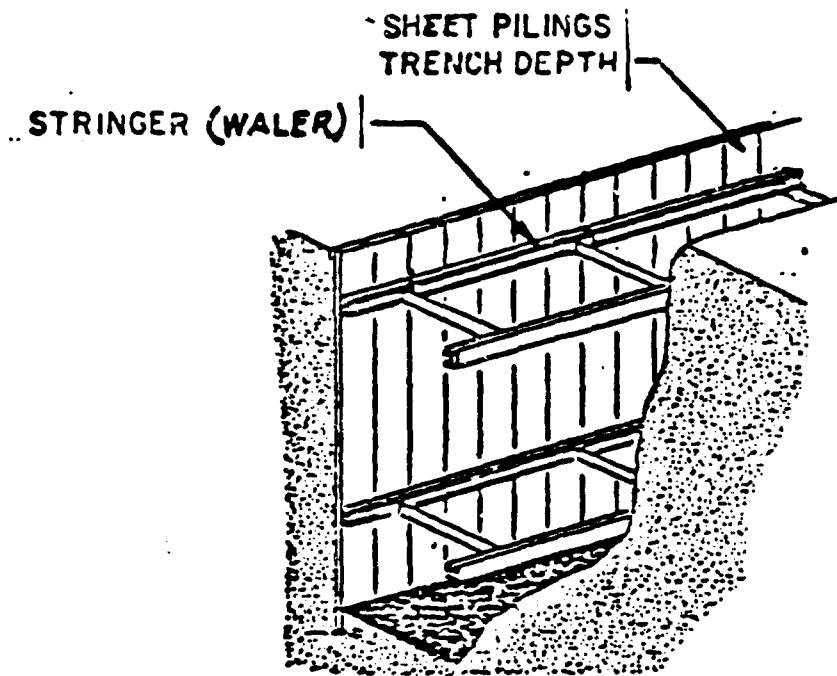
Plate C-24-c

**MINIMUM SHORING REQUIREMENT  
IN HARD COMPACT SOIL**

CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Adopt new Appendix Plate C-24-d to read:

**CLOSE SHEETING METHOD  
1. IN RUNNING SOIL**



**HYDRAULIC  
SHORING**

**RUNNING MATERIAL  
SOLID SHEETING  
IS REQUIRED**



8. BOSTON, MASSACHUSETTS, WORKSHOP - WRITTEN COMMENTS AND  
CORRESPONDENCE



ASSOCIATION OF SOIL AND FOUNDATION ENGINEERS

REPLY TO

Mr. William S. Zoino  
c/o Goldberg-Zoino &  
Associates, Inc.  
Newton Upper Falls, MA 02164

July 17, 1981

Mr. Felix Yokel  
U.S. Dept. of Commerce  
National Bureau of Standards  
Bldg. 266, Rm. B162  
Washington, D.C. 20234

Re: Boston OSHA Subpart P  
Workshop

Dear Felix,

I thought that the workshop in Boston went quite well, and I am happy to see that we have now finished in all the cities. I have three brief comments I wish to pass along to you.

1. Section 1926.652 (b) (5) (iii)

If excavations up to 2 feet (or 3 feet) are allowed below the bottom of sheeting in short-term excavations, I think that the longitudinal length of such excavations should be limited. Obviously, if the length is limited, the soil can conveniently arch around the area to provide room for excavation of a utility line, and so forth. But I do not think that a long stretch of such excavation below the sheeting should be allowed.

2. Long-Term versus Short-Term Excavations

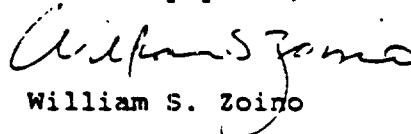
As you know, there was considerable discussion on this point as to what is a reasonable definition of "long-term." My personal choice is anything in excess of one day, and anything less than one day should be considered "short-term." However, as a maximum, I think three days to accommodate a weekend would be a practical limit to a short-term excavation. In this respect, I think you should also add sensitive clays or sensitive soils to the list of those soils where the shear strength may deteriorate with time due to disturbance and vibrations in the area.

Mr. Felix Yokel - July 17, 1981 - Page Two

3. As you know, there was much discussion on the possibility of the registered professional engineer certifying the work. I do not think there is any practical way this can be accomplished. The reason is simply that the behavior of the excavation is dependent not only on the design parameters utilized by the geotechnical engineer, but is also based on the method and quality of workmanship of the contractor. These two contributions to movement and deformation are inseparable, and therefore, it is impossible to put the burden entirely on the design engineer. While I personally prefer that deep excavations be designed by a registered professional engineer; nevertheless, we must recognize that it is the contractor who is responsible for the work area and for everything that goes on within the work area. Consequently, the contractor should be given the latitude to design the excavation himself, using his own experienced, competent people. Whether or not they are registered professional engineers is a moot point.

By copy of this letter to John Ramage, I am asking John to review all the comments and input to this date and, if necessary, to correspond with you further on this subject.

Sincerely yours,

  
William S. Zoino

WSZ:lab

Enclosure

cc: John Ramage  
Jim Kleinfelder

Boston



A 100-year start on tomorrow

July 13, 1981

Comments by Kodak Park Division of Eastman  
Kodak Company at Boston, MA, Workshop,  
Trenching & Excavation Standards, on Working  
Draft prepared by National Bureau of Standards  
dated February 20, 1981.

The Kodak Park Division of Eastman Kodak Company does a large portion of the construction and maintenance of its buildings and underground utility lines. This includes excavations for buildings and other major structures as well as trenching for new water, sewer, and electric services. It also includes excavation for emergency repair of these underground services. We are also involved with many trenching and excavation contractors at all of our locations in the U.S. and expect that the execution of this work be done safely and efficiently.

The hazards of inadequately shored or braced excavations are well recognized by experienced persons active in that type of construction. Unfortunately, satisfactory source standards were not available when OSHA promulgated the existing 1926 standards and their subsequent enforcement efforts have not been entirely productive in the reduction of serious accidents or in providing assistance in needed safety precautions.

We believe that the National Bureau of Standards has done a commendable job in drafting these suggested revisions. They have recognized that excavation site conditions are widely variable and the application of judgment for each location by knowledgeable people is needed. The proposed standard is written in performance language and the supplemental non-mandatory guidelines that are included should be very helpful in the solution of specific problems. Eastman Kodak supported a similar approach used by OSHA in the revision of the General Industry Standards for Fire Protection which were adopted last December, and the Electrical Workplace Standards which were adopted in April 1981.

Attached are our comments on the identified issues plus some addition items. We will be pleased to elaborate on these comments if additional information would be helpful.

Some Issues that Should be Considered in the Workshop

1. Page 6. Section 1926.651(a): This section appears to fall within the scope of Subpart S. Should it be dropped?

A. Subpart S, Tunnels and Shafts, Caissons, Cofferdams, and Compressed Air is not the appropriate place to call for locations of utilities prior to excavation. The problem of interrupting utilities and the resulting employee hazards are most likely to be found while preparing surface excavations and thus belongs in Subpart P.

2. Page 8. Section 1926.651(p): Should the exit requirements for excavations start at 5 ft rather than 4 ft depth?

Please refer to our general comments on this section.

A. Yes, it is reasonable to expect the type of individuals who work in excavations to have the strength and agility to make his own way out of a 5 ft deep excavation without the aid of something or someone else. Also, the additional one-foot allowance will include many trenches, and a pipe is often present which would serve as a step to aid the exit process. Also, in trenches, the work is being done in a constantly changing location and the need to frequently move the ladder or exit device may be considered a nuisance by the trench workers if they do not believe it is practical to use.

Should exit requirements be waived for excavations which are wide enough to permit people to escape toward the center of the excavation?

A. Yes, the major concern for death or injury is in the relatively narrow excavations such as trenches where escape during rapid cave-in is very much more difficult because escape options are far fewer than in wider excavations. The alternative requirement should be that the excavated area allow unimpeded movement away from the excavation walls to a safe location.

Should it be recognized that large enough pipes or other covered structures can shelter people?

The intent of this question is not clear. A large pipe being installed can serve as a temporary refuge, but it does not seem appropriate to include that as part of a planned protection system in lieu of shields or shoring. However, a permissible practice would be to permit the use of the pipe as a shelter while the trench shield is being relocated which is a normal procedure in many situations. Alternatively, existing large pipes or structures adjacent to the excavated area can serve as a type of shoring to help support the excavation side. Good judgment and sometimes engineering analysis may be required, however, for the use of pipes that appear to give marginal support.

Should "negotiable slope" be better defined?

A. This definition seems adequate for its purpose, though there may be some arguments about a person's ability to climb a slope being used. Perhaps the only validation required should be a physical demonstration of an employee using the slope to egress or ingress before work begins.

3. Page 9. Section 1926.652(a)(2)

a) Could the depth limitation in the "Standard Practice" be extended to 24 ft?

Whether the excavation is 20 ft or 24 ft before requiring the services of a registered engineer is somewhat arbitrary. There should be some limit, however, and since the 20 ft limit has been used in several standards, such as the New York State Code Rule 23, it probably should be kept.

b) Should a "qualified person" be substituted for an "engineer"?

There are probably relatively few registered engineers who would be competent in the design of earth shoring systems or slopes, and there are probably many capable people who are not registered professional engineers who have developed suitable expert qualifications in this area. The definition of "qualified person" probably is more descriptive than the definition for "engineer" in determining a person competent in designing shoring systems and earth slopes.

4. Page 10. Section 1926.652(b)(1): Should the short-term excavation definition extend to 7-days rather than 1-day? If so, do we need more conservative requirements?

We do know that a 7-day definition for short-term excavation can be applied to most soil conditions in our area. The more commonly found soils which may range in grain sizes from clays to gravels would most likely permit a 7-day short-term definition in other parts of the country as well.

There are basically two conditions which normally change the strength of insitu soil with time after an excavation has been made, both having to do with changes in water content:

1. If an excavation is dug below the water table surface, or if an excavation is partially filled with water and this water is rapidly drawn down by pumping, relatively large pore water pressures between the soil particles remain. This may cause a temporary stability problem which will improve with time as excess pore pressures dissipate. So, when excavating primarily fine grain or relatively impermeable soils such as clays and silts, the initial water condition is important. When the walls stabilize after the water is pumped out, short-term excavation criteria can be safely applied, as long as the excavation is not allowed to refill with water. Paragraph 1926.651(d) and note 3(b) of table 1 of the draft Subpart P revision recognize this problem.
2. When excavating in granular or permeable soils such as sands, there will be a temporary apparent cohesion caused by negative pore pressures in the partially saturated, draining soils. This negative pore pressure is caused by capillary tension. As the soil in the excavation walls dries, the negative pore pressures will dissipate making the soil weaker in shear and possible causing sloughing or slides. This is a condition which will deteriorate with time and the length of time will depend on how fast the soil in the excavation walls will dry to a significant depth. Probably in normal conditions, instability will occur considerably later than 7 days after the excavation work, particularly when the excavation wall is covered with sheeting, retarding evaporation of water.

We feel the large majority of the cases will allow the extension of short-term to 7 days. Perhaps an extension to 3 days might be a good compromise which would allow, as a worst case, excavation before a weekend to backfilling after a weekend, as long as water is not allowed to accumulate in the excavation and be pumped down again.

5. Page 11. Table 1: Should the stipulation of maximum slope be limited to 3/4:1? Should the suggested performance requirement (footnote b)(the "stable slope" concept) be used? Will this approach work?

A. The 3/4:1 maximum slope should be reasonable.

Judgments of the description of the soil encountered, degree of saturation and changing conditions as the excavation progresses might overlook something, possibly resulting in a marginal stability problem from time to time. There should be some means to correct such shortcomings if there is evidence of instability, and the provision to flatten the slope by 1/4:1 should be appropriate. This adjustment should be made before anyone enters the excavation.

6. Page 12. Figure 2: Should the allowable bank next to the work area in Cases II, III, and IV be increased to 4 ft? Should "Case IV" be limited to excavation by trenching machines?

A. The purpose, usually, for having a sub trench at the bottom of a sloped excavation is to provide a better lateral restraint for the pipe after the pipe is bedded and in place. This, in most cases, allows the pipe to withstand greater overburden and ground surface loads without failure. For large pipes (6 ft or more in diameter), it may be important to be allowed a deeper sub trench. For employee safety purposes, whether 3 or 4 ft is used is arbitrary, and would probably depend on judgment of the increased risk, if there is any, by going to the 4 ft sub trench. The potential volume of sliding soil, indicated by the spaces between the solid and dotted lines in figure one, does seem to be relatively small even at 4 ft. The upper portion of the trench would have to be widened or flattened to accommodate the 4 ft sub trench in order to meet the table 2 criteria. Finally, at 4 ft, the head and shoulders of most workers would be outside of the sub trench. It seems reasonable to us to extend the sub trench depth to 4 ft.



7. Page 13. Section 1926.652(b)(4)(ii): This section, unlike most others in Subpart P, is not addressed to the man in the field but to those who pre-design shoring systems. Yet the section is necessary to avoid unreasonable vagueness. Should this section be at the end of Subpart P? Should part of it be conveyed as definitions?

A. These loadings are already in the, "Guidelines Supplementing Subpart P, Section 2.2.2, 'Operational Loads'." If these loadings, with the possible exception of the impact load, are meant to also apply to job designed shoring, which Subpart P does not say, then these provisions should remain in the body of this Subpart where they are.

8. Page 16. Section 1926.652(b)(5)(ii): This section makes it difficult to implement some of the slope configurations allowed in figure 2. Should the proposed performance statements be substituted to give more options, or alternatively, should more options be specified or the specified options identified as examples of implementing the performance statement?

A. The performance statement, (Workers in excavations must be protected against rolling or sliding objects.) is really all that is needed here. Suggestions as to how this may be accomplished may be placed in the appendix if beneficial.

No mention of the amount of slope required before provisions are applied should be made. It depends on the specific situation.

9. Page 16. Section 1926.652(b)(5)(iii): Should the allowable excavation below the bottom of shoring or shields be increased to 3 ft?

A. It certainly would be useful, in some cases, to be able to extend short-term excavations to 3 ft below the shoring. It is useful to aid in the bedding of pipe. Also, more importantly to us, it better allows working around underground obstructions with shoring, particularly when reexcavating to repair a broken watermain, sewer, or similar items in a congested area. We feel it is reasonable to allow this extension if adequate attention is paid to possible unstable conditions below the shoring.

We also believe this section should be reworded to clarify that the short-term excavation requirement applies to the work below the bottom of the sheeting or shoring system. An excavation for a building or large structure would come under the long-term definition. It is often necessary to make short-term excavations within this excavation for drain lines, footings, etc. The present wording could be interpreted as prohibiting this practice. We suggest that this section be revised to read:

"A short-term excavation up to 3 ft below the bottom of sheeting, trench shields, or trench boxes is permitted provided that:."

10. Page 18. Definition of accepted engineering requirements. Should a "registered architect" be omitted since architects do not deal with excavations?  
 A. This is not an area in which architects are normally involved, however, there is probably no good reason why they should be excluded, as long as they have adequate background and experience, just as any registered engineer working with excavations should.
11. Page 18. Definition of "Competent Person." Should the definition be rewritten to require that the competent person be working at the excavation site?  
 A. We would consider this to be good practice.
12. Should "Mass Movement of Soil or Rock" be defined?  
 A. The term should be self-explanatory. It should include any ground movement involving volumes greater than those associated with spalling of rock, or sloughing of soil and surface erosion of soil. Perhaps the latter terms should be defined. The only place these terms appear in Subpart P is in the definition of "Fractured Rock."
13. Page 52. Old 1926.651(c): Should this statement be deleted? Even though this matter is addressed elsewhere, this statement conveys the intent of Section 1926.652 in simple language.  
 A. This statement should be deleted. It is clearly redundant with the new Section 1926.652(a).

In addition to "Some Issues that Should be Considered in the Workshops," we have some additional comments or questions.

1. Page 7. Section 1926.651(e): We feel that this requirement should apply to completed portions of excavations. This would clarify that the intent is not apply the shoring requirement in the areas where the excavation equipment is working. Substitute "completed sides" for "side" in line 4.
2. Page 7. Section 1926.651(g): Excavating equipment may be considered mobile. Is it necessary to place stop logs or barricades in front of this equipment during excavation, particularly tracked equipment or those using outriggers?
3. Page 8. Section 1926.651(p): This section currently appears to apply only to trenches. We believe exit conditions should be considered for all types of excavations. Large excavations should have a minimum of two means of exit. A second condition could be a smaller excavation of up to approximately 1500 sq ft where one exit would be permitted. A third condition would be similar to what is currently proposed.
4. Page 11. Table 1: Recognizing that many times the excavation faces are saturated only part of the way up, could we consider the soil to be type C to the top of the saturation zone and types A or B above that with the appropriate We's applied?
5. Page 11. Table 1: The Matrix Classification System shown in NBS BSS 127, June 1980, is simple to use and offers more flexibility. Would it be possible to replace in Subpart P the simplified Classification System with the Matrix Classification System, or at least offer the latter in an appendix or another section as an alternate.
6. Page 18. Section 1926.653(j): Excavation  

The draft standard does not define trench or give any criteria to distinguish between a trench or excavation as is done in the current standards. We believe this is desirable. However, it may be helpful to add a sentence to the excavation definition stating that trenches are excavations or alternatively adding a Trench definition which could state,

Trench: "One type of excavation commonly used for the installation of piping, etc."

This would provide emphasis to employers who primarily do trench type excavation work that the entire standard is applicable to their operations.

7. Page 19. Section 1926.653(1): Fractured Rock

Can rock have fractures in it and yet be considered by definition unfractured? It is rare to find especially sedimentary rock that is not fractured, yet we would consider that much of it would not readily spall or crumble when excavated with vertical slopes. We believe unstable rock would be a more suitable term for this definition.

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OAKLAND NJ 07436



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20:3372233 MGM TDMT OAKLAND NJ 126 07-10 0222P EST

► FELIX YOKEL  
NATIONAL BUREAU OF STANDARDS  
RT 270  
QUINCE ORCHARD BLVD  
GAITHERSBURG MD 20760

AFTER RECEIVING THE WORKING DRAFT OF THE SUGGESTED REVISION IN  
SUB-PART P OF THE SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION I  
WANTED TO EXPRESS OUR SUPPORT FOR THE PROPOSED CHANGES QUITE ASIDE  
FROM ANY MINOR SUGGESTIONS WE COULD OFFER WITH REGARD TO DEFINITIONS  
THAT SHOULD BE CONSIDERED WE'RE IN COMPLETE AGREEMENT WITH YOUR  
ENGINEERING ASSUMPTIONS AS THEY PERTAIN TO TRENCH SHORING BOXES WE  
UTILIZE ENGINEERING PRINCIPALS AS PROPOSED BY TERZAGHI AND PECK IT IS  
OUR FEELING THAT IT IS THE MOST CONSERVATIVE YET MOST APPLICABLE  
THEORY PERTAINING TO TRENCH SHORING WE'RE PLEASED THAT WE SHOULD SOON  
HAVE INDUSTRY STANDARDS AND GUIDELINES TO WHICH ALL MANUFACTURERS  
WILL COMPLY

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PRODUCTION, INC.

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July 17, 1981

Mr. John Maragliano, Gen. Mgr.  
D & J INDUSTRIAL STEEL FABRICATORS, INC.  
45 Edison Avenue  
Oakland, New Jersey 07436

Dear John:

Both Wendell Wood of GME and myself were very disappointed that you did not attend the meeting of the workshop on the proposed revisions to Subpart P of the OSHA regulations.

It was the hope of both GME and ourselves, as I stated to you on the phone on July 9, 1981, that even if we did have some areas of disagreement we would be able to get together and iron these out so that we could present a consensus opinion as an industry, so that it would not appear that there was a division within our industry, and thereby provide a more effective presentation as an industry to the NIOSH Study.

Dr. Yokel informed us at the meeting that you had telephoned him on Monday, July 13, and that you disagreed with our position totally. It's hard for us to believe that you would have total disagreement, and that there would be that much of a difference when, obviously, we have a common purpose to provide the construction industry with adequate, well designed, quality products.

I got the impression from our phone conversation that you concurred with many of the statements that we made. It is my recommendation, and sincere hope, that you will see fit to share and communicate with us, so that the final results of our work will be a unified presentation. I am certain that any differences we have can be ironed out to the satisfaction of all concerned.

It is my understanding that Dr. Yokel, in the next 60 days, will generate a summary of all the work shops and recommend a formation of an industry study committee with representation on that committee by all parties concerned. It is our hope that you will participate with us in the development of an acceptable standard so that the trench box industry can play the part that is necessary in that study committee.

July 17, 1981  
Mr. John Maragliano  
Page Two (2)

John, enclosed is a copy of our most recent presentation statement presented at the Boston meeting. Both Wendell Wood and myself would appreciate it if you would take the time to review and comment on each item in detail so that we can see where we differ, then we can evaluate our position as it relates to yours and start the process of generating a consensus position.

Looking forward to hearing from you soon.

Sincerely,

EFFICIENCY PRODUCTION, INC.

John B. Cook  
Vice Pres. & Gen. Mgr.

Enc.

cc: Dr. Felix Yokel  
Mr. Wendell Wood

JBC/slc

Boston July 14, 1981

STATEMENT OF POSITION AND RECOMMENDATIONS  
ON  
REVISION TO SUBPART P  
OF THE  
SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION  
PRESENTED BY  
THE MAJOR MANUFACTURERS OF TRENCH BOXES  
AND TRENCH SHIELDS OF THE UNITED STATES

John B. Cook  
Efficiency Production, Inc.

Wendell Wood  
Griswold Machine & Engineering



## GENERAL STATEMENT OF POSITION

A review in detail has been made of the proposed revisions in Subpart P 1926.650 - .651 - .652 - .653.

This review was made by, and on behalf of, the major trench box manufacturers of the United States, and represents their consensus opinion of the changes in the proposed standards.

It is our position that the intent to clarify and simplify, as it relates to the revised changes of Subpart P, has failed, and in fact, has made it more confusing and more difficult to apply in the field. The proposed design criteria as they relate to trench boxes do not conform to accepted engineering practices. We have specific recommendations for changes in the proposed revisions.

It is also our position - that if the Guidelines are going to be referenced within Subpart P and therefore become effectively a part of the law - they should be discussed publicly as a part of the workshop and in public hearings.

1926.650 GENERAL PROTECTION REQUIREMENTS - NO COMMENT

1926.651 SPECIFIC EXCAVATION REQUIREMENTS

PAGE

- 8 - item (s)      Should read ... Portable trench boxes or sliding trench shields may be used for the protection of personnel. Where such trench boxes or trench shields are used they shall be designed, constructed and maintained in a manner which will provide equivalent protection to that provided by the shoring required for the excavation as defined by accepted engineering practice.

1926.652 SPECIFIC SHORING, SLOPING AND SHIELDING REQUIREMENTS

PAGE

- 9 - item 2a      Should read ... Qualified Engineer
- 10 - item (b) (1)      Should be no arbitrary distinction between long-term and short-term excavation.
- 10 - item (4) (i)      We recommend that this section be clarified and simplified for effective field application.
- 13 - item (ii) a      Should read ... lateral pressure at the bottom of excavation equal to the equivalent weight effect ( $W_e$ ) in Table 1 times the depth of cut with lateral pressure diagram appropriate to the construction as determined by an engineer.
- We object to the footnotes attached to Table 1 as being too technical and overly complicated for interpretation by field personnel, and recommend they be simplified.
- 13 - item (ii) c      The last paragraph of this section should read ... shoring systems shall be designed in accordance with accepted engineering practices.

PAGE

(This statement excludes the 33% increase in allowable working stresses or an equivalent strength reduction.)

13 - item (iii)  
Paragraph 2

Should read ... Shoring systems and trench shields shall be selected in the field on the basis of accepted engineering practice.

13 - item (iii) (a) Trench shields, trench boxes, and pre-fabricated strutwale assemblies and other pre-fabricated assemblies shall be rated for the maximum depths in all types of soils in which they can be selected and used accordingly from charts prepared by the manufacturer.

16 - item (4)(iii)(c) Should read ... rated by an engineer ... .

16 - item (5)(iii) Should read ... Excavation up to 3 feet below the bottom of sheeting, trench boxes, or trench shields is permitted provided that: ... (and we agree with items a & b.)

1926.653 DEFINITIONS APPLICABLE TO THIS SUBPART

PAGE

18 a

Should read ... Accepted engineering practices, those requirements or practices which are compatible with standards required by a registered professional engineer.

Question - why are you making reference to the guidelines when they are not meant to be a part of the law?

19 m

Should be eliminated.

19 o

Should read ... Negotiable slope is a slope on which a person can egress from or ingress to an excavation with relative ease and speed to assure reasonable safety.

PAGE

19 t

Should be eliminated.

19 z

Should read ... See Figure 4 (Correction)

GUIDELINES SUPPLEMENTING SUBPART P

If the Guidelines are going to be referenced within Subpart P, do they not become effectively a part of the law? If so, they should be discussed publicly as a part of the workshop and in public hearings.

ANSWERS TO DR. YOKEL'S QUESTIONS

- #1 No comment.
- #2 No comment.
- #3 No comment on 24 foot limitation.  
On question of should qualified person be substituted for engineer ... "No, as it relates to this specific question."
- #4 No distinction should be made between short-or long-term excavation.
- #5 No comment.
- #6 No comment.
- #7 Yes, and should be conveyed as part of the definitions.
- #8 No comment.
- #9 Yes.
- #10 Yes.
- #11 No comment.
- #12 No.
- #13 No - Statement should not be deleted.

Boston  
Comments of Richard V. Brescia, President  
Brescia Construction, Inc.  
Caribou, Maine

For the Boston Region Workshop on the Proposed Revisions to Subpart P of the  
Safety and Health Regulations for Construction

July 14, 1981

Ramada Inn - Airport, Boston

1) Section 1926.652(a)(1) Short term excavation definition

I would suggest that if neither the 24-hour or seven day definition is found acceptable that a compromise definition of four days be used.

2) Section 1926.652(a)(2) "Qualified Person" definition

I endorse the substitution of "qualified person" for "engineer" in this section. I would suggest, however, that OSHA in cooperation with the industry, develop a one or two day training course for superintendents and foremen engaged in trenching and shoring to insure their qualification. Superintendents would be required to pass a simple examination on the material, and could be certified as "qualified". Foremen would be required to attend the training course, but would not be required to take the examination. Primary responsibility for on-site operations and safety would rest with the "qualified" superintendent.

9. SOURCE DOCUMENTS FROM WHICH PRESENT TECHNICAL PROVISIONS IN  
SUBPART P WERE DERIVED

When NBS studied the present provisions in Subpart P of the Safety and Health Regulations for Construction, an attempt was made to determine the origin of the technical provisions in the document. The attached documents contain some of the information which was used as a basis for preparing some of the provisions, particularly those for timber shoring (Table 2). Note that the documents were written in the early 1940's.

SAFETY BOARD - Pursuant to the provisions of Section 4 of the District of Columbia Industrial Safety Act (Public Law 271 - 77th Congress - Chapter 438 - 1st Session), the District of Columbia Minimum Wage and Industrial Safety Board hereby calls a public hearing for the purpose of investigating reasonable standards of safety in employment, places of employment, in the use of devices and safeguards, and in the use of practices, means, methods, operations, and processes of employment, and any person interested in the matter being investigated may appear and testify. Said meeting will be held in Municipal Center Building, 300 Indiana Avenue, N. W., on Thursday, September 2, 1943, at 10 a.m.

MRS ALBERT W. ATWOOD, Chairman  
FRED S. WALKER, P. Y. K. Howat

GOVERNMENT OF THE DISTRICT OF COLUMBIA  
MINIMUM WAGE AND INDUSTRIAL SAFETY BOARD  
AND

EIGHT-HOUR DAY LAW DIVISION  
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MRS ALBERT W. ATWOOD, CHAIRMAN  
FRED S. WALKER  
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ELIZABETH CHAMPE  
EXECUTIVE SECRETARY  
EDWARD J. BUNKER  
DIRECTOR OF INDUSTRIAL SAFETY

August 25, 1943

To be inserted in legal notices of newspapers on August 26 or August 27, 1943.

MINIMUM WAGE AND INDUSTRIAL SAFETY BOARD - Pursuant to the provisions of Section 4 of the District of Columbia Industrial Safety Act (Public Law 271 - 77th Congress - Chapter 438 - 1st Session), the District of Columbia Minimum Wage and Industrial Safety Board hereby calls a public hearing "for the purpose of investigating reasonable standards of safety in employment, places of employment, in the use of devices and safeguards, and in the use of practices, means, methods, operations, and processes of employment, and any person interested in the matter being investigated may appear and testify." Said meeting will be held in Municipal Center Building, 300 Indiana Avenue, N. W., on Thursday, September 2, 1943, at 10 a.m.

Mrs. Albert W. Atwood, Chairman  
Fred S. Walker  
P. Y. K. Howat



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*Minimum Wage Board*



②

Proposed Code as used  
at Public Hearing

GOVERNMENT OF THE DISTRICT OF COLUMBIA  
MINIMUM WAGE AND INDUSTRIAL SAFETY BOARD

CODE II  
CONSTRUCTION SAFETY CODE  
(Proposed)

PART 25 EXCAVATING, DEMOLITION, BLASTING

SECTION 251 EXCAVATION

2510. DEFINITIONS. A. Excavation shall mean an uncovered cutting in the earth.

B. Excavating shall mean the operation of making or digging an excavation.

C. Shoring shall mean props, braces, planks, sheeting, etc., placed and held against the side of an excavation to prevent slips, slides, cave-ins, or the falling of earth.

2511. GENERAL. A. The sides of excavations 5 feet or more in depth shall be supported by substantial and adequate sheeting, sheet piling, bracing, shoring, etc., or the sides of the excavation sloped to the angle of repose of the material being excavated, where there is apparent danger of slides, slips, or cave-ins, and where under-cutting of banks or walls of the excavation is pertinent to the excavation system. Such protection shall be consistent with the magnitude of the work and the character of the material in which the excavation is made.

B. Shoring shall be placed as soon after excavating as the excavating operations will permit.

C. Foundations adjacent to an excavation which is lower than the foundation shall be supported by shoring or underpinning as long as the excavation remains open.

D. Excavated or other material shall not be stored within 2 feet of the edge of an excavation.

E. A guardrail shall be installed, or other effective barricade provided, at or near the edge of an excavation as soon as possible, except where such barricade will interfere with operations.

F. Red lights, torches, or other illuminated warning signs shall be placed and maintained from sunset to sunrise on excavation barricades and along the edges of unbarricaded excavations which are adjacent to paths, walkways, sidewalks, driveways, or thoroughfares.

G. Precautions, in addition to those given below, may be required, by the Director, in excavations subjected to vibrations from moving equipment or other conditions.

H. Insofar as practicable, measures shall be taken to prevent the entrance or accumulation of surface water in excavations, behind the shoring, or on the tops of banks of excavations, where it is likely to soften or weaken the soil or subsurface material and cause slips, slides, or cave-ins.

I. The side of an excavation shall not be undercut in excess of 6 inches unless the overhang is supported by adequate shoring or underpinning.



J. Sketches showing approved methods of shoring are shown on page \_\_\_\_.

K. Excavations more than 4 feet in depth shall be provided with ladders or equivalent means of egress, extending from the bottom of the excavation to at least 3 feet above the top. The interval between ladders in trenches shall not exceed 50 feet.

2512. TRENCH EXCAVATION. A. The following requirements apply to any trench 5 feet or more in depth and 6 feet or more in length which serves as a workplace, except where the trench is in solid rock, hard shale, or hard slag.

1. Trench shoring, not less than the "Minimum Requirements" given in the table on the following page, shall be provided.

2. The combination tunnel-trench method may be used in hard, compact soil, provided that a single trench section does not exceed 8 feet in length, and that the length of earth left in place over the tunnel between the trench sections is not less than half the depth of the trench. In other than hard, compact earth, the trench sections shall be provided with shoring not less than specified in the "Minimum Requirements."

3. Cross braces and jacks shall be so placed, fastened, and maintained that they will not slip or buckle.

4. Workmen shall not be required or permitted to work in a tunnel section unless the earth above is supported by adequate underpinning.

## Trench Shoring

## Minimum Requirements

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Depth of Trench	Kind or Condition of Earth	Size and Spacing of Members									
		Uprights		Stringers		Cross Braces*				Max. Spacing	
		Min. Dim.	Max. Spac.	Min. Dim.	Max. Spac.	Width of Trench					
						Up to 3 ft.	3 to 6 ft.	6 to 9 ft.	9 to 12 ft.	Vert.	Horiz.
Feet		Inches	Feet	Inches	Feet	Inches	Inches	Inches	Inches	Feet	Feet
5 to 10	Hard, compact	3 x 4 2 x 6	8	-	-	2 x 6	4 x 4	4 x 6	6 x 6	4	8
	Likely to crack	"	3	2 x 6	4	"	"	"	"	"	"
	Soft, sandy, or filled	"	Close sheeting	4 x 6	"	4 x 4	4 x 6	6 x 6	6 x 8	"	"
	Hydrostatic pressure	"	"	6 x 6	"	"	"	"	"	"	"
10 to 15	Hard	"	4	-	-	"	"	"	"	"	"
	Likely to crack	"	2	2 x 6	4	"	"	"	"	"	"
	Soft, sandy, or filled	"	Close sheeting	4 x 6	"	4 x 6	6 x 6	6 x 8	8 x 8	"	"
	Hydrostatic pressure	"	"	8 x 10	"	"	"	"	"	"	"
15 to 20	All kinds or conditions	"	Close sheeting	4 x 12	"	-	6 x 6	8 x 8	8 x 10	"	"
Over 20	All kinds or conditions	"	"	6 x 8	"	-	8 x 8	8 x 10	10 x 10	"	"

\*Trench jacks may be used in lieu of, or in combination with, cross braces.

Shoring is not required in solid rock, hard shale, or hard clay.

Where desirable, steel sheet piling, and lagging of equal strength may be substituted for wood.



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American Standard Safety Code for  
**Building Construction**

SPONSORS

American Institute of Architects  
National Safety Council

Approved June 7, 1944

American Standards Association

## PART 2

# Excavation Work

### SECTION 0 Definitions

0.1 Equipment. "Equipment" shall mean ladders, scaffolds, ramps, runways, railings, barricades, sheet piling, shoring, bracing, and any such safeguards, protective construction, and devices used in affording protection to the men engaged in excavating work.

0.2 Jack. A "jack" shall mean a mechanical or hydraulic device to lift, lower, or move a load by man power applied through leverage.

0.3 Ramp. A "ramp" shall mean any inclined runway including those constructed entirely of dirt.

0.4 Runway. A "runway" shall mean any planked over walkway or drive constructed and maintained as a passageway for workmen or rolling equipment. (See rule 5.6 in Part 2.)

0.5 Shaft. A "shaft" shall mean a hole sunk into the ground at an angle of forty-five (45) degrees or less with the vertical.

0.6 Trench. A "trench" shall mean a narrow excavation made below the surface of the ground. In general the depth will be greater than one of the horizontal dimensions.

0.7 "c to c." "c to c" shall mean center to center.

### SECTION 1 General

1.1 This Part on "Excavation Work" provides for the protection of the public, employees, and property during all excavation work in connection with building and trenching operations, including related sub-surface or below grade-level work such as the underpinning, shoring, and bracing of foundations, retaining walls, and the like.

1.2 Any device or equipment used in connection with excavation work shall be constructed, installed, inspected, maintained, and operated by the owner or user as specified in applicable parts of this code.

1.3 Where applicable, federal, state, or local codes, rules, regulations, and ordinances governing any and all phases of excavation work shall be observed at all times.

1.4 Trees, boulders, and other surface encumbrances located so as to create a hazard at any time

during operations shall be removed before excavating is started.

1.5 If the stability of adjoining buildings or walls is endangered by excavations, shoring, bracing, or underpinning shall be provided as necessary to ensure their safety. Such shoring, bracing, or underpinning shall be frequently inspected by a competent person and the protection effectively maintained.

1.6 Excavations shall be inspected after every rainstorm or other hazard-increasing occurrence, and the protection against slides and cave-ins increased if necessary.

1.7 If it is necessary to place or operate power shovels, derricks, trucks, material, or other heavy objects on a level above and near an excavation, the side of the excavation shall be sheet-piled, shored, and braced as necessary to resist the extra pressure due to such superimposed loads.

1.8 The sides of every excavation four (4) feet or more in depth, where there is danger of slides or cave-ins, shall be supported by substantially braced sheet piling or shoring unless the sides of the excavation are sloped to the angle of repose of the material being excavated.

1.9 Whenever any part of an excavation is protected by a masonry wall, such wall shall be braced to ensure stability. This shall not include reinforced concrete walls known to be of ample strength.

1.10 Temporary sheet piling which has been installed to permit the construction of a retaining wall shall not be removed until such wall has acquired its full strength.

1.11 Except in hard rock, excavations below the level of the base or footing of any foundation or retaining wall shall not be permitted unless the wall is underpinned and all other precautions taken to ensure the stability of the adjacent walls for the protection of the men.

1.12 Undercutting of earth banks shall not be permitted unless they are adequately shored.

1.13 Excavated material shall not be placed on the ground surface nearer than eighteen (18) inches from the edge of the excavation.

1.14 All fixed-in-place ladders and stairways giving access to levels twenty (20) or more feet apart shall be provided with landing platforms at vertical intervals of twenty (20) feet. Every landing

platform shall be equipped with standard railings and toe boards.

1.15 Lumber sizes, when used in this Part, refer to nominal sizes.

## SECTION 2

### Protection to the Public

2.1 All public walkways, sidewalks, and thoroughfares bordering on or running through any construction site shall be provided with substantial guardrails or board fences. In addition, temporary footwalks beyond the curb shall be substantially constructed and provided with protection on both sides.

2.2 Sidewalks and walkways shall be kept clear of excavated material or other obstructions and no sidewalks shall be undermined unless shored to carry a live load of one hundred and twenty-five (125) pounds per square foot.

2.3 If planks are used for sidewalks or raised walkway protection, they shall be laid parallel to the length of the walk and fastened together against displacement.

2.4 Planks shall be uniform in thickness and all exposed ends shall be provided with beveled cleats to prevent tripping.

2.5 Raised walkways shall be provided with plank steps on strong stringers. Ramps used in lieu of steps shall be provided with cleats to insure safe walking.

2.6 A flagman or watchman shall be designated to warn the public of the approach of trucks and to direct the trucks in and out of the property. Danger or warning signs shall be posted at all truck entrances and exits.

2.7 During the hours of darkness, all public sidewalks and walkways shall be adequately illuminated, and warning lights or flares shall be placed about the property to ensure safety for pedestrian and vehicular traffic.

2.8 The public shall not be required or permitted to travel under loads handled by power shovels, derricks, or hoists, unless ample side barricades and overhead protection are provided.

## SECTION 3

### Sheet Piling, Shoring, and Bracing

3.1 All shoring, bracing, or sheet piling shall be consistent with the magnitude of the work and the character of the soil or material in which the excavation is made.

3.2 If workmen are engaged near the face of an excavation, where the ground is cracked or of such

character that caving is likely to occur, sheet piling with shoring and bracing necessary to prevent caving shall be provided.

3.3 All material used for shoring, bracing, and sheet piling shall be sound straight-grained timber equal to long leaf yellow pine, Douglas fir, or other material of equal strength. All timber shall be free from splits, shakes, large or loose knots, and shall be of the required dimensions throughout.

3.4 Wooden sheet piling shall be not less than two (2) inches in thickness and the thickness shall be increased as may be necessary to adequately support the sides of the excavation. (See rule 6.13.)

3.5 Where temporary sheet piling is used during excavation work, the shoring and bracing to be provided shall comply with the following requirements.

3.6 When shores and braces are required they shall be placed at intervals or not more than eight (8) feet measured parallel with the sheet piling.

3.7 Shores or braces shall bear at the earth against a footing of sufficient area to keep within the allowable soil pressure, "dead men" being buried when necessary to resist the thrust of the braces.

3.8 Shores or braces at the sheet piling shall not be cut to a bevel but shall be held by wedges and the wedges shall be nailed.

3.9 The timber shores or braces shall be designed as columns, the following formula being recommended:

$$P = A \left( 1300 - 20 \frac{L}{D} \right)$$

where:

$P$  = total permissible load in pounds.

$A$  = cross sectional area of timber in square inches.

$L$  = unbraced length of timber in inches.

$D$  = least dimension of cross section of timber in inches.

3.10 The shores or braces shall make an angle not greater than thirty (30) degrees with the horizontal.

NOTE: For excavations more than sixteen (16) feet in depth, or when heavy lateral pressures are encountered, the use of interlocking steel sheet piling is recommended. Choice of piling should be made from recognized standard tables. Piling must be driven sufficiently below the bottom of the excavation to resist the overturning moment. Steel or timber bracing can be added where necessary.

## SECTION 4

### Jacks

#### A. General

4.1 The rated capacity of every jack shall be legibly marked in a prominent location on the jack by casting or stamping.

4.2 To prevent loading beyond the rated capacity, the manufacturer shall designate in printed matter, or otherwise, the intended supporting point of the load and the maximum permissible length of lever and force applied.

4.3 If auxiliary load-supporting points are provided, the manufacturer shall also designate the rated capacity for these points.

4.4 The design of all jacks shall incorporate a positive stop to prevent over-travel or an indicator where a positive stop is impracticable.

4.5 The design shall be such that parts may be replaced without requiring special adjustment of either the replacement part or other parts of the jack.

4.6 Printed instructions concerning the lubrication and operation of the jacks shall be secured from the manufacturer.

4.7 Lubrication instructions furnished by the jack manufacturer shall be closely followed.

4.8 When the object has been lifted to the desired height, blocking or cribbing shall be immediately placed under it.

4.9 A capable man shall be appointed and held responsible for the inspection of all jacks at regular intervals. The inspection shall be made in accordance with rules governing "Inspection of Jacks," below.

#### B. Inspection of Jacks

4.10 Jacks shall be examined for cracked, distorted, or worn parts and to ensure that they are receiving proper lubrication. Time of examination shall depend upon service conditions as follows:

- (a) For constant or intermittent use at one locality, thorough inspection once every week,
- (b) For jacks shipped between shop and job, thorough inspection when sent out and when returned,
- (c) For jacks upon which abnormal load or shock has occurred, thorough inspection immediately, by foreman in charge.

4.11 Jacks which are found to have cracked, distorted, or badly worn parts shall be tagged "out of order" and not re-used until repairs are made.

4.12 Repair or replacement parts shall be examined for possible defects, and only parts which fit perfectly shall be used.

4.13 Before being returned to service, repaired jacks shall be subjected to test and shall meet the same requirements as when new.

### SECTION 5 Ramps and Runways

5.1 Ramps or runways used for vehicles shall have a width of not less than twelve (12) feet. Timber guards not less than eight (8) inches by eight (8) inches shall be securely fastened on top of the runway along each of the outside edges.

5.2 Ramps or runways, when used as passageways for workmen, shall be provided with standard railings.

5.3 All ramps and runways shall be maintained in a safe and serviceable condition. When ramps and runways are formed on hard ground without the use of planking, ruts and holes greater than two (2) inches deep shall not be permitted.

5.4 When the pitch of the ramp requires it, a man shall be alongside a loaded truck with a chock provided with a strong handle for blocking a rear wheel if the truck is stalled or otherwise forced to stop on the ramp.

5.5 Workmen, other than chockers, shall be instructed to stay off ramps and runways when trucks are passing over them.

5.6 Where the incline of the ramp is too steep for safe walking, foot cleats, not more than sixteen (16) inches apart, shall be provided to prevent slipping.

### SECTION 6 Trenches

#### A. General Requirements

6.1 In all trench operations where men are at work or where they must pass to and from their work, sufficient light, either natural or artificial, shall be provided at all times.

6.2 Pick and shovel men working in trenches shall be kept a sufficient distance apart to prevent injury to one another.

6.3 All trenches four (4) feet or more in depth shall at all times be supplied with at least one (1) ladder for each one hundred (100) feet in length or fraction thereof. The ladder shall extend from the bottom of the trench to at least three (3) feet above the surface of the ground.

6.4 Red lanterns or torches shall be placed along the exposed sides of all trenches at night as required for necessary warning to the public.

6.5 Guardrailings or barricades shall be provided at or near the sides of trenches as necessary to protect the workmen and the public.



6.6 The sides of all trenches which are four (4) feet or more in depth, and where the earth is not sloped to the angle of repose, shall be securely held by timber bracing. The bracing shall be carried along with the excavation and must in no case be omitted unless the trench is cut in solid rock or hard shale.

6.7 Where a mechanical digger is used, the bracing shall be placed as close as possible [a maximum of six (6) feet is recommended] to the lower end of the boom.

6.8 The bracing shall be held in place by screw jacks or by cross braces cleated and wedged in place. Where the width of the trench prevents this, the lower end of the cross brace shall bear against a footing in the earth at the bottom of the trench, provided adequate means are taken to keep it from kicking out.

6.9 When the sloping of trenches to the angle of repose does not extend to the bottom of the trench, the timbering shall be as required to support the vertical part of the trench. The sheeting shall extend not less than twelve (12) inches above the bottom of the slope and, if necessary, to boards shall be placed behind the timbering to prevent material from sliding into the trench. The surface of the slope shall be cleaned of boulders, stumps, or other hard masses of earth to eliminate the danger of their sliding into the trench.

6.10 Excavated material and superimposed loads shall not be placed nearer than eighteen (18) inches from the sides of the trench, unless bracing has been installed and designed to withstand the load.

6.11 When trenches are undercut, they shall be shored to safely support the overhanging material.

6.12 If a trench is cut alongside an existing structure and the footings of the structure are nearer to the trench than the plane of repose for the soil, they shall be underpinned or the side wall of the trench rigidly supported.

6.13 Considering the planks used for sheet piling as beams to support the load imposed by the lateral earth pressure, the maximum allowable distance between the horizontal stringers or wales shall be such as will keep the planks within their safe bending stress. (See rule 3.4.)

6.14 Where the cross section of the horizontal stringer or wale is not square, the greater dimension shall be placed in a horizontal plane to gain the maximum strength of the member.

6.15 Braces shall be considered as column or struts and shall be of adequate dimension for stiffness. (See rule 3.9.)

6.16 In hand excavated trenches, cleats shall be spiked or bolted to join the ends of braces to stringers to prevent the braces from being knocked out of place. In mechanically excavated trenches, all cleats shall be bolted.

6.17 When the depth of the trench requires two (2) lengths of sheet piling, one above the other, the lower length shall be set inside the bottom stringers or wales of the upper length and driven down and braced as the excavation continues.

### B. In Trenches of Varying Widths and Depths

In trenches of varying widths and depths the use of the following timbers is recommended and any deviations therefrom shall be on the side of safety.

6.18 For trenches from four (4) feet to ten (10) feet in depth and not more than forty-two (42) inches in width:

#### (a) In hard solid soil

Uprights: 2×6 in. planks spaced approximately 6 ft apart c to c  
Stringers: None  
Cross Braces: Two 2×6 in. planks for depths less than 7 ft  
Three 2×6 in. planks for depths 7 ft to 10 ft

If the nature of the soil or parallel excavations close to trenches necessitate the spacing of uprights closer than six (6) ft, they may be held in place by two by six (2×6) in. horizontal stringers or wales and cross braces spaced not more than six (6) ft apart c to c.

#### (b) In soil likely to crack

Uprights: 2×6 in. planks spaced approximately 3 ft apart c to c  
Stringers: 2×6 in. planks placed near bottom and top of trench  
Cross Braces: Two 2×6 in. planks for depths less than 7 ft  
Three 2×6 in. planks for depths 7 ft to 10 ft  
Cross braces spaced horizontally not more than 6 ft apart c to c

#### (c) In soft sandy soil or filled ground

Uprights: 2×6 in. close sheeting  
Stringers: 4×6 in., two for depths less than 7 ft, three for depths 7 ft to 10 ft  
Cross Braces: 4×6 in., spaced horizontally not more than 6 ft c to c

6.19 For trenches from ten (10) feet to fifteen

(15) feet in depth and not more than forty-two (42) inches in width:

(a) *In hard solid soil*

Uprights: 2×6 in. planks spaced approximately 4 ft apart c to c

Stringers: None

Cross Braces: Three 2×6 in. planks for depths less than 13 ft

Four 2×6 in. planks for depths 13 ft to 15 ft

In lieu of one cross brace to each upright, and where the nature of the soil or nearby parallel excavations makes the spacing of uprights closer than four (4) ft, they may be held in place by two by six (2×6) in. stringers or wales, and cross braces spaced not to exceed six (6) ft c to c.

(b) *In soil likely to crack*

Uprights: 2×6 in. planks spaced 3 ft apart c to c

Stringers: 2×6 in. planks, three in the height of the trench

Cross Braces: Three 2×6 in., for depths less than 13 ft

Four 2×6 in., for depths 13 ft to 15 ft

Cross braces spaced horizontally not more than 6 ft apart c to c

(c) *In soft sandy soil or filled ground*

Uprights: 2×6 in. close sheeting

Stringers: 4×6 in., three for depths less than 13 ft, four for depths 13 ft to 15 ft

Cross Braces: 4×6 in., spaced horizontally not more than 6 ft apart

6.20 For trenches more than fifteen (15) feet in depth and not more than forty-two (42) inches in width:

(a) *In soil of all kinds*

Uprights: 2×6 in. close sheeting

Stringers: 4×12 in., spaced vertically not to exceed 4 ft c to c

Cross Braces: 4×12 in., spaced horizontally not to exceed 6 ft c to c

6.21 For trenches from four (4) to ten (10) feet in depth, and more than forty-two (42) inches in width:

(a) *In hard solid soil*

Uprights: 2×6 in. planks spaced approximately 6 ft apart c to c

Stringers: 4×6 in., spaced vertically 4 ft apart c to c

Cross Braces: 4×6 in., spaced horizontally 6 ft apart c to c

(b) *In soil likely to crack*

Uprights: 2×6 in. planks spaced 3 ft apart c to c

Stringers: 4×6 in., spaced vertically 4 ft apart c to c

Cross Braces: 4×6 in., spaced horizontally 6 ft apart c to c

(c) *In soft sandy soil or filled ground*

Uprights: 2×6 in. close sheeting

Stringers: 4×6 in., two for depths less than 7 ft, three for depths 7 ft to 10 ft

Cross Braces: 4×6 in., spaced horizontally 6 ft apart c to c

6.22 For trenches from ten (10) to twenty (20) feet in depth, and more than forty-two (42) inches in width:

(a) *In soil of all kinds*

Uprights: 2×6 in. close sheeting

Stringers: 6×6 in., spaced vertically 4 ft apart c to c

Cross Braces: 6×6 in., spaced horizontally 6 ft apart c to c

6.23 For trenches more than twenty (20) feet in depth, and more than forty-two (42) inches in width:

(a) *In soil of all kinds*

Uprights: 2×6 in. close sheeting

Stringers: 6×8 in., spaced vertically 4 ft apart c to c

Cross Braces: 6×8 in., spaced horizontally 6 ft apart c to c

### C. In Trenches with Hydrostatic Pressure

6.24 For trenches not more than eight (8) feet in depth:

Uprights: 2×6 in. tongued and grooved close sheeting

Stringers: 6×8 in., spaced vertically 4 ft apart c to c

Cross Braces: 6×8 in., spaced horizontally 6 ft apart c to c

6.25 For trenches more than eight (8) feet in depth:

Uprights: 3×6 in. tongued and grooved close sheeting

Stringers: 8×10 in., spaced vertically 4 ft apart c to c

Cross Braces: 6×8 in. or 6×10 in., spaced horizontally 5 ft apart c to c

The greater dimension of the stringers shall be placed at right angles to the sheeting

6.26 Where desired, steel sheet piling and bracing may be substituted for wood.

## SECTION 7 Power-Driven Shovels

### A. General Requirements

7.1 The operator of every shovel shall be protected by a cab, screen, or other suitable means in case a cable should break or material fall from a dipper when raked in close to the machine at a high level.

7.2 No unauthorized person shall be allowed on the operating platform when the shovel is in operation, and the machine operator shall not converse with anyone while operating the machine.

7.3 A suitable ladder or steps and handholds shall be provided to afford safe and easy access to the operating platform.

7.4 All shovels when not in use shall be left with the dipper on the ground.

7.5 In case of a breakdown, the shovel should, if practicable, be moved well away from the foot of the slope before repairs are made.

7.6 All persons shall be warned to keep away from the range of the shovel's swing, and to avoid being struck by the cab as it rotates.

7.7 Workmen shall not be permitted to stand back of the shovel or in line with the swing of the dipper when the shovel is in operation or being moved.

7.8 The trucks of all power shovels shall be inspected regularly, particular consideration being given to brakes and steering gear. All defects shall be promptly repaired.

7.9 Shovels shall be inspected each morning before starting work.

7.10 All oiling and greasing of equipment shall be done when the machine is shut down.

7.11 Operators shall not be permitted to leave the cab while the master clutch is engaged.

7.12 Whenever it is necessary to move the shovel under electric wires, ample clearance shall be provided, together with such precautions as may be necessary to prevent contact between any part of the shovel and the wires.

7.13 The wire rope on power-operated shovels shall be regularly inspected and shall be changed when ten (10) percent of the wires in any three (3) foot length are broken.

### B. Electric Shovels

7.14 All wiring and electrical apparatus shall be installed, equipped, and maintained according to the rules of the local code governing such equipment and all applicable rules of the National Elec-

trical Code and the National Electrical Safety Code.

7.15 Temporary wiring shall be properly grounded to minimize the danger of shock.

7.16 In the handling of electrical equipment, experienced electricians and operators shall be employed to do the work.

### C. Steam Shovels

7.17 Steam boilers shall be installed, equipped, and maintained as provided in the boiler code of the American Society of Mechanical Engineers, and tested in accordance with the rules of local authorities.

7.18 The boiler and all steam pipes shall be insulated, and all other necessary precautions taken to protect workmen from burns.

7.19 Before starting, the drip cocks in the pipes leading from the boiler to the engine shall be opened and the cylinders and pipes drained.

7.20 Drains and blow-offs shall discharge under the shovel or the discharge pipe shall be shielded to protect persons passing or working near the shovel.

7.21 Every boiler shall be provided with safety valves, gage cock, and steam pressure gage.

### D. Compressed-Air and Gasoline Shovels

7.22 The compressor, air receiver, and other parts of the compressed-air equipment shall be installed, equipped, and maintained as prescribed by the local code and regulations governing such equipment, and the receiver shall comply with the ASME Code On Unfired Pressure Vessels.

7.23 Every compressor shall be provided with approved safety devices, including a safety valve, pressure gage, and fusible plug.

7.24 Only a mineral oil having a high flash point shall be used for lubricating air compressors, and the quantity carefully regulated.

7.25 All automatic controls shall be inspected daily and kept in first class working condition.

7.26 Compressors shall always be supplied with a plentiful supply of cooling water kept in continuous free circulation, unless the compressors are air cooled.

7.27 Smoking in the vicinity of gasoline shovels shall be prohibited.

7.28 No lights other than approved vapor-proof incandescent electric lights shall be used in connection with gasoline shovels.

7.29 Gasoline shovels shall be effectively grounded and otherwise protected against the hazards of static electricity.

7.30 When transporting gasoline from the general supply to the equipment in five (5) gallon quantities or less, safety cans of the non-spill type shall be used.

7.31 If tank truck service is not available, gasoline in quantities in excess of five (5) gallons shall be transported in steel drums or barrels. All bungs shall be tight, and the drum checked to prevent movement.

7.32 No open lights shall be used when transporting gasoline. Electric flash lamps only shall be used.

7.33 When gasoline is pumped from drum to storage tank on the equipment, a hose with a metallic nozzle shall be used. The pump must be of a type which does not create pressure inside the drum.

7.34 When gasoline is being pumped into the storage tank, the engine of the shovel shall be shut down.

7.35 A fire extinguisher of suitable type shall be placed on or convenient to every shovel or other similar piece of operating equipment.

## SECTION 8

### Trucks

- 8.1 Only experienced and physically fit drivers shall be allowed to operate automobile trucks.

8.2 Brakes, steering gear, tires, and all operating parts of trucks shall be inspected daily; such inspections should, preferably, be made before trucks are taken from the garage or storage area for the day's work.

8.3 All employees shall be strictly prohibited from:

- (a) Riding on trucks unless specifically authorized to do so,
- (b) Riding anywhere on a truck except in the seat beside the driver, unless the truck body is equipped with fixed-in-place seats, a rear gate, and a safe means of getting on and off,
- (c) Getting on or off moving vehicles.

8.4 Truck engines shall never be allowed to run idle in closed garages or other enclosed places.

8.5 All parts and accessories of trucks shall be kept in good repair and safe condition. Trucks with broken or cracked parts or defective tires shall be

removed from service until the defects have been corrected.

8.6 On material which projects beyond the rear end of any truck using a public highway there shall be tied or fastened to the projecting end of the material:

- (a) A red flag during the daylight hours
- (b) A red light during the hours of darkness

8.7 No person shall be permitted to remain on a truck when it is being loaded by a power shovel or to remain within reach of the swing of the dipper.

8.8 Material shall never be loaded on a truck so as to project horizontally beyond the sides of the body nor so that it can be jarred off due to vibration during transit.

8.9 Trucks while being loaded shall be properly blocked where there is a possibility of their moving by gravity, vibration from blasts, or other causes.

8.10 Loads not fully contained within the body of the truck shall be secured by means of chains, cables, ropes, or other effective devices.

8.11 The backing up of trucks shall be controlled by a signal man who shall have a clear view of the driver and the area behind the truck during each backing-up operation.

8.12 Completely deflated tires on trucks shall never be inflated until after the load has been removed by jacking up the truck. Truck drivers and mechanics shall be instructed in this procedure.

8.13 Dump bodies of dump trucks shall be blocked or cribbed before inspecting, servicing, or repairing while hoisted.

## SECTION 9

### Wheelbarrows

9.1 Wheelbarrows with split or cracked handles shall not be used.

9.2 Wheels shall be strong, true running, and well secured to the frame.

9.3 When wheelbarrows are used in narrow passageways, knuckle guards shall be provided.

9.4 Workmen shall not be permitted to run with empty wheelbarrows with the handles in an up-right position.

9.5 Wheelbarrows shall never be left in such a position that they can readily tip over or fall.

10. MISCELLANEOUS INPUT AND INFORMATION

The correspondence in this section was sent to NBS at various times and is not associated with any particular workshop.



1515 Wilson Boulevard Arlington Va 2220.  
Telephone (703) 841-8400

September 11, 1981

Dr. Felix Y. Yokel  
Center for Building Technology  
National Engineering Laboratory  
National Bureau of Standards  
Washington, D.C. 20234

Dear Dr. Yokel:

The American Gas Association (A.G.A.) is a national trade association which represents nearly 300 national gas transmission and distribution companies serving over 160 million consumers in all 50 states. The gas utility industry employs about 215,000 people with a payroll in excess of \$4 billion.

Representatives from the A.G.A. attended two of the recent workshop sessions on NBS Building Science Series 127 "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations," written as a basis for proposed changes to Subpart P of 29 C.F.R. Part 1926. Two of the potential changes discussed cause particular concern. First, consolidating excavation and trenching rules into a single regulation and, second, comments proposing a 3 foot set-back for excavations.

The A.G.A., although not in the construction industry, is currently being regulated under 29 C.F.R. Part 1926, including Subpart P for trenching and excavations. We, therefore, have a vital interest in these standards.

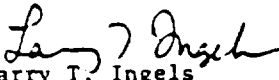
As a primary goal we desire to be exempted from construction industry standards. Since we have not yet attained that goal we must in the meantime insure that any changes to the current regulations on trenching and excavations in 29 C.F.R. Part 1926 consider our special interest in trenching. As implied previously, we see particular significance in retaining the distinction between trenching and excavations.

Our distribution companies, which by nature of our business operate in urban areas, are greatly affected by the OSHA trenching and excavation regulations, especially the 2 foot set-back rule. Inspection of gas lines by OSHA have occurred in spite of the fact that trenching cave-ins are not a problem within our industry as documented by our safety record. Equally as important, trenching operations by gas companies, both distribution and transmission, come under the safety jurisdiction of the Office of Pipeline Safety within the Department of Transportation. The DOT rules are promulgated under 49 C.F.R. Parts 191 and 192. This potential for dual jurisdiction over trenching safety regulations between OSHA and DOT causes confusion. For additional discussion of our safety record in trenching and the jurisdictional issue—see the attachment.

We, therefore, request that any revision to excavation and trenching standards in 29 C.F.R. Part 1926 include the following statement: "Natural Gas companies directly involved in pipeline activities covered by 49 C.F.R. Parts 191 and 192, as promulgated by the Department of Transportation are exempt from Subpart P of 29 C.F.R. Part 1926 standards relating to excavation and trenching operations."

For additional information on this subject, please contact Larry T. Ingels, 703/841-8454 or Randall Griffin, 703/841-8481 at A.G.A. Headquarters in Arlington, Virginia.

Sincerely,

  
Larry T. Ingels  
Manager, Engineering  
Services Programs

LTI:lbp

## OVERLAPPING JURISDICTION BETWEEN OSHA AND DOT

### SUMMARY OF ARGUMENT

- I. The natural gas utility industry should not be grouped with the construction industry. Standards developed for the construction industry should not, therefore, be applied to the natural gas utility industry.
  - A. The natural gas utility industry is fundamentally distinct from the construction industry. Safety records support this contention.
  - B. The natural gas utility industry took no part - and had no opportunity to take part - in the development of the Construction Industry Standards 29 C.F.R. Part 1926.
- II. OSHA jurisdiction is preempted under Section 4(b)(1) of the Occupational Safety and Health Administration Act of 1970 (OSH Act) when other Federal agencies "exercise statutory authority to prescribe or enforce standards or regulations affecting occupational safety or health."
  - A. The Department of Transportation exercised its statutory authority under the Pipeline Safety Act of 1968 by promulgating regulations relating to pipeline operations and maintenance (49 C.F.R. Part 192) and by enforcement of those regulations.
  - B. DOT's regulations preempt OSHA jurisdiction over pipeline and trenching operations, rendering OSHA regulations in Part 1926 inapplicable to the natural gas utility industry.
- III. The American Gas Association (A.G.A.), therefore, requests that OSHA refrain from citation of the natural gas utility industry under Part 1926.



## INTRODUCTION

The American Gas Association (A.G.A.) is a national trade association which represents nearly 300 natural gas transmission and distribution companies serving more than 160 million consumers in all 50 states. These companies account for nearly 85% of the nation's total annual gas utility sales.

The natural gas utility industry is regulated at each and every stage of their business. Many of these regulations, including OSHA's "General Industry" standards in 29 C.F.R. Part 1910, are recognized as validly applying to our industry. We do not believe, however, that the "Construction Industry" standards of 29 C.F.R. Part 1926 should be enforced against the natural gas utility industry. We recommend that OSHA institute a policy of not citing the natural gas utility industry under Part 1926 for the following reasons.

I. The natural gas utility industry should not be grouped with the construction industry.

According to the National Safety Council data for 1978, the gas utility industry had an incident rate of 2.69 per 100 full-time workers and a severity rate of 15.98 lost work days per injury. This compares very favorably with the construction industry statistics of 3.94 injuries per 100 full-time workers with a severity of 20.81 lost work days per injury. Furthermore, a review of safety statistics relating directly to trenching and pipeline activities indicates that the natural gas utility industry has an exceptionally good safety record.

- During the six year period (1975 - 1980) 3,837 immediate injury reports were received by A.G.A.
- Of the above total only 7 were in the accident category which includes cave-ins and none have been documented as fatalities.
- These few injuries generally occurred in trenches or excavations belonging to someone else who called the gas company to repair a line damaged during excavation.
- Scaled to the entire industry, this type of accident - "caught under, in or between a mineral item" which would include cave-ins - would represent only one-sixth of one percent of the total injuries.
- From this extremely low rate of incidence, it may be concluded that cave-ins involving trenches or excavations are not a significant problem within the natural gas industry.

Additionally, the segment of the gas utility industry most likely to be engaged in the pipeline and trenching activities labelled "construction" by OSHA - natural gas transmission companies - have incident rates of less than half of the overall gas utility rate.

The large difference in the incident rates between transmission companies engaged in trenching activities and construction companies occurs because trenching and pipeline activities of gas utility companies are performed by relatively few employees at any given workplace. Construction industries, on the other hand, may have a large number of employees performing a wide variety of tasks at the same workplace. Due to disparate rates and levels of risk, the standards designed for the construction industry are not appropriate to apply to the natural gas utility industry.

The construction industry standards of Part 1926 have been applied to the natural gas utility industry without giving that industry an opportunity to provide input. These standards were developed under the Contract Work Hours and Safety Standards Act of 1962, (as amended Pub. L. 91-54 of 1969; 40 U.S.C. §333), to regulate construction crews working under government contracts. In order to cover these crews comprehensively, the standards were defined very broad to cover, "construction, alteration, and/or repair including painting and decorating..."

The OSH Act of 1970 gave the Secretary of Labor the authority to promulgate as occupational safety and health standards, without the notice and comment requirements of the Administrative Procedures Act, any "national consensus standard and any established Federal standard." §6(a) of the OSH Act, 29 U.S.C. Section 655(a). The natural gas utility industry had no need to comment on proposed regulations when these regulations applied only to Federal contractors. There was no opportunity for the gas utility industry to comment on the regulations when they were promulgated as occupational safety and health standards.

In this context, the 10th Circuit opinion U-30, Inc. v. Marshall and OSAHRC, 7 OSHC 1253 (10th Circuit 1980), should be reviewed. The Court found that there was "no indication in the record...that the oil drilling industry had any part or was consulted in the development of the construction industry standards." The Court then held that the construction industry standard relating to cranes and derricks used in constructing buildings could not be applied under the "general duty clause" of Section 5(a)(1) of the OSH Act to the oil drilling industry.

A.G.A. believes that the safety record of the natural gas utility industry and the rationale outlined above strongly support the establishment of an OSHA policy of not citing the natural gas industry under Part 1926.

## II. A Policy of Not Citing Under Part 1926 is Legally Justified

OSHA has been granted authority by the Secretary of Labor to make and enforce regulations for the minimum federal safety standards for all industries. The Secretary of Labor's authority in this area is derived from the OSH Act of 1970, 29 U.S.C. Section 651, et seq. In order to avoid overlapping jurisdiction and the inefficiencies and costs of overlapping jurisdiction, Congress limited the Secretary's authority. The limitation, Section 4(b)(1) of the OSH Act (20 U.S.C. Section 653(b)(1)), provides that:

"Nothing in this chapter shall apply to working conditions of employees with respect to which other Federal agencies... exercise statutory authority or regulations affecting safety or health."

It is A.G.A.'s position that the Office of Pipeline Safety (OPS) of the Department of Transportation has exercised its statutory under the Natural Gas Pipeline Safety Act of 1968 by promulgating regulations entitled "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards." 49 C.F.R. Parts 191 and 192. These regulations comprehensively cover operation and maintenance of pipelines, mandate safe working procedures to be documented in an operating and maintenance plan, and impose strict reporting and other requirements in case of emergency, among other safety related requirements.

An important concept to keep in mind when reviewing the OSHA Part 1926 regulations is that the OPS regulations need not be parallel in form or substance to the OSHA regulations in order to preempt jurisdiction.

"Whether the OPS standards are the same or substantially different from the OSHA standards their content is of little moment. In Mushroom Transportation Co., Inc., No. 1588 (1974) own authority over specific working conditions, OSHA cannot enforce its own regulations covering the same conditions. Section 4(b)(1) does not require that another agency exercise its authority in the same manner, or an equally stringent manner." Secretary v. Texas Eastern Transportation Corp., 20 OSHA 712, 717 (1975) (emphasis added by Commission) (Citations omitted.)

This concept is important to keep in mind because the OPS regulations are generally structured in terms of maintaining the integrity of the pipeline and prevention of hazardous situations. The prevention of hazardous situations is mandated through performance language rather than the prescriptive language generally employed by OSHA.

An example of preemption of an OSHA standard by an OPS standard which varied significantly from the form of the OSHA standard can be found in Columbia Gas of Pennsylvania v. Secretary and OSAHRC, No. 80-1459, (9th Cir., December 23, 1980.) In that case, Columbia Gas was cited for a serious violation of an OSHA regulation — 29 C.F.R. §1926.652(v) — requiring atmospheric testing of an excavation where oxygen deficiency or gaseous conditions are possible, prior to use of equipment that could cause accidental ignition. It should be noted that Section 1926.652(v) requires compliance with Subparts C and D of Part 1926 in which a large number of specific requirements are mandated as to personal protective equipment and engineering controls. In contrast, the OPS regulation, 49 C.F.R. Section 192.751, provides simply that:

Section 192.751 Prevention of Accidental Ignition

Each operator shall take steps to minimize the danger of accidental ignition of gas in any structure or area where the presence of gas constitutes a hazard of fire or explosion, including the following:

- (a) When a hazardous amount of gas is being vented into open air, each potential source of ignition must be removed from the area and a fire extinguisher must be provided.
- (b) Gas or electric welding or cutting may not be performed on pipe or on pipe components that contain a combustible mixture of gas and air in the area of work.
- (c) Post warning signs, where appropriate.

The OPS regulation does not specifically refer to the repair of a pipeline using a "hot tap" procedure at issue in the case, (tapping into a pipeline without interrupting the flow of gas in the pipeline), nor does it mandate detailed requirements in a manner similar to OSHA's. Nevertheless, the Third Circuit held that the OPS regulation covered the "exact working conditions" purportedly within OSHA's jurisdiction.

Therefore the Court ruled that "this OPS regulation provides safety standards for the exact conditions of this case and hence find that Section 4(b)(1) preempted OSHA's authority over the matter."

The above case strongly supports the argument that the DOT has exercised its statutory authority and preempted OSHA's jurisdiction over the natural gas utility industry in the areas of pipeline-safety and trenching.

- A.G.A. recommends that OSHA examine closely its regulations, particularly the excavation and trenching regulations, under Part 1926 for overlap with DOT regulations. We recommend that special attention be given to the safety provisions found in Subparts L and M of Part 192 of the OPS regulations. We believe that such an examination will demonstrate that the DOT regulations comprehensively provide for employee safety during pipeline and trenching activities. A policy of not citing these activities under Part 1926 will leave no gap in the safety net protecting gas utility industry employees.

ALUMINUM HYDRAULIC  
SHORING SYSTEMS

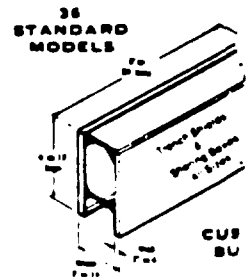


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May 28, 1981

Felix Y. Yokel PhD P.E.  
Center for Building Technology  
National Bureau of Standards  
Washington, D. C. 20234

Dear Felix:

Have just received the schedule for the A.G.C. Workshops and I shall be attending by invitation of the AFL-CIO.

I think the guide lines fall somewhat short because you did not include isometric drawings to cover good trench shoring and bracing practices. I have prepared the enclosed drawings and recommend they be included with the documents.

I also suggest the following changes:

1. Ref: p.9

I see no reason why the depth limitation in the "Standard Practice" cannot be extended to 24' depth. Also no reason why the limits of Class C soils should be more stringent than they already are, since we recommend tight sheeting as it is now, so long as the bracing (struts, wales and sheeting) are strong enough to withstand the expected loads.

2. Ref: Should a qualified person be substituted for an engineer?

In the definition of who is a qualified person, to whom is the ability demonstrated?

3. Ref: p.10

I think the short term excavation definition could be extended to 3 days or 72 hours, but no more. Reason being the one day short-term would unduly penalize contractors as over the week-end he would have to shore for long term excavations as it is now written.

4. Ref: p.11

I do not feel the stipulation of maximum slope should be limited to 3/4:1 because there are a number of soil conditions that could require a 1:1 slope and even a 1 1/2:1 slope.

page 2

Suggested changes.

5. Ref: p.12

Under certain conditions I feel the bank next to the work area in cases 2, 3, and 4, could be increased to 4'. I do not believe that in case 4 we should try to limit to excavations by trenching machines only.

6. Ref: p.13

I believe this section should be included in the engineering section as this could be lost on the man in the field.

7. Ref: p.16

In this case I think the specified options identified as examples of implementing the performance statement should be pursued.

8. Ref: p.16

Excavations up to 3' below the bottom of the sheeting or trench boxes, I feel could be allowed under conditions as stated in iii A. & B.

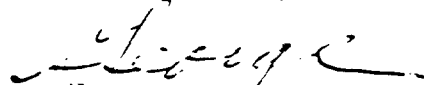
9. Ref: p.18

In "accepted engineering requirements" I think that a regular architect should be omitted, since architects do not deal with excavations.

10. Ref: p.18

I do not see how we could not require that a competent person be working at the excavation site.

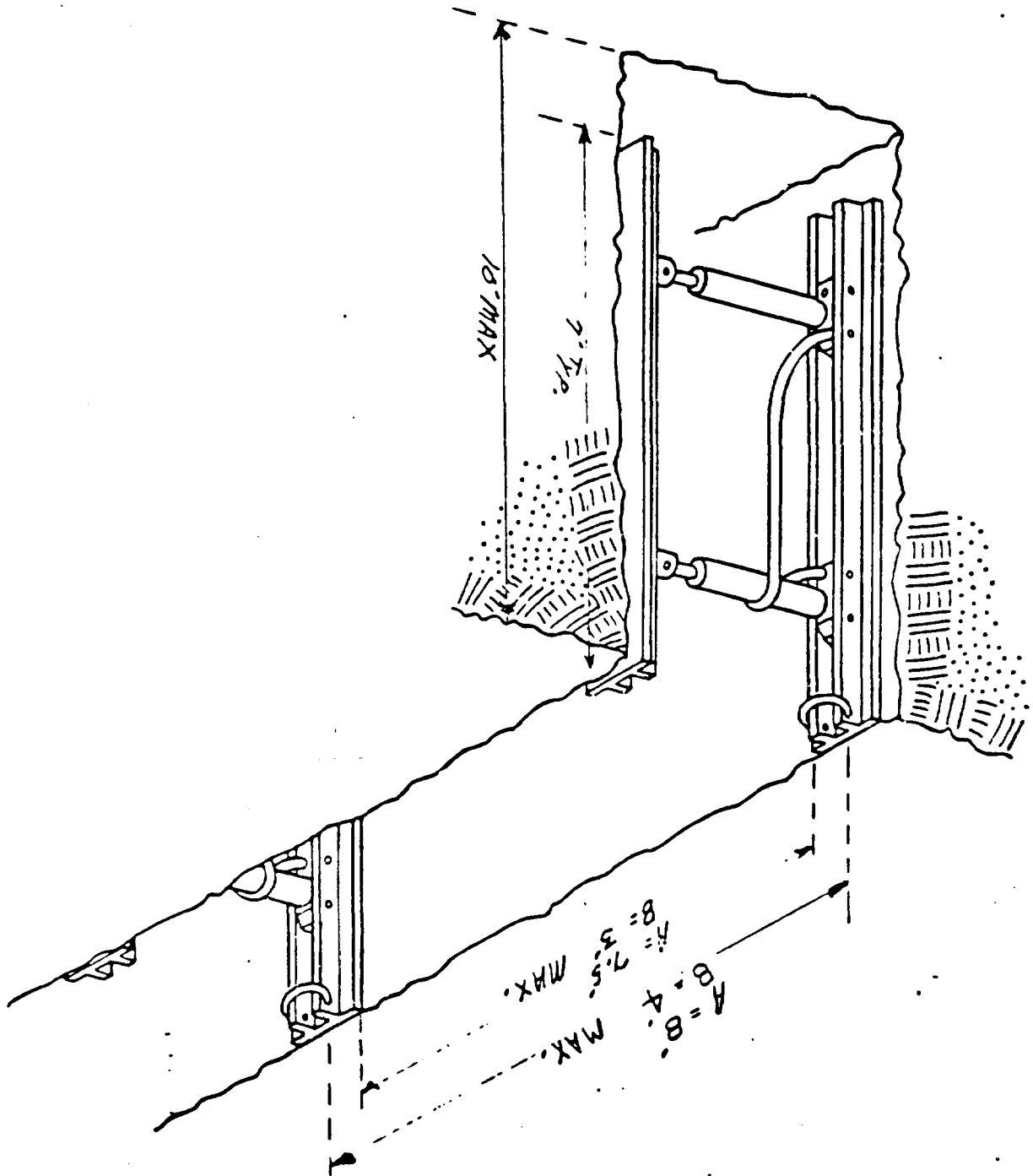
Sincerely yours,

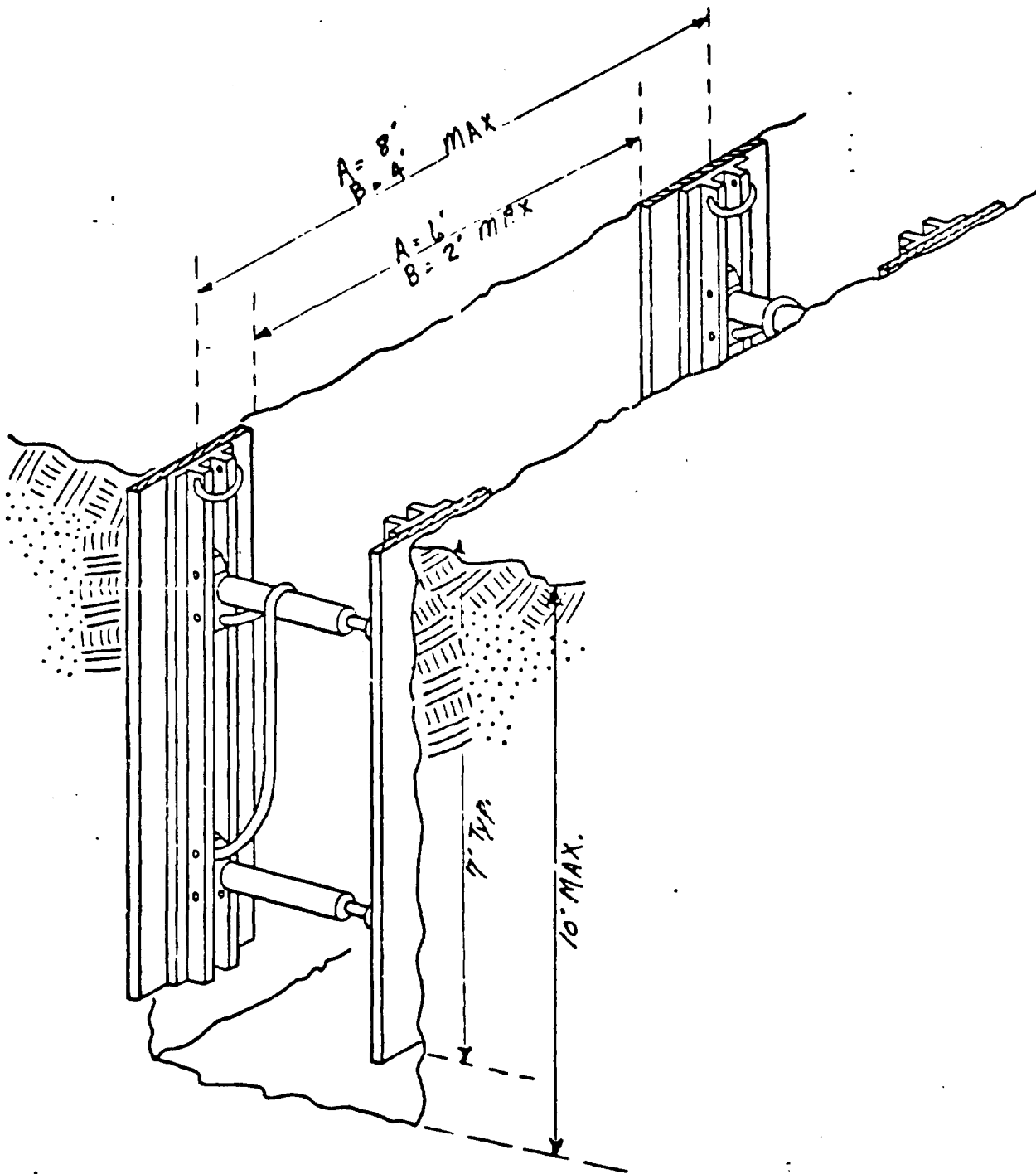
  
George Bradberry

GB:gtb

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713 6-3 6.55

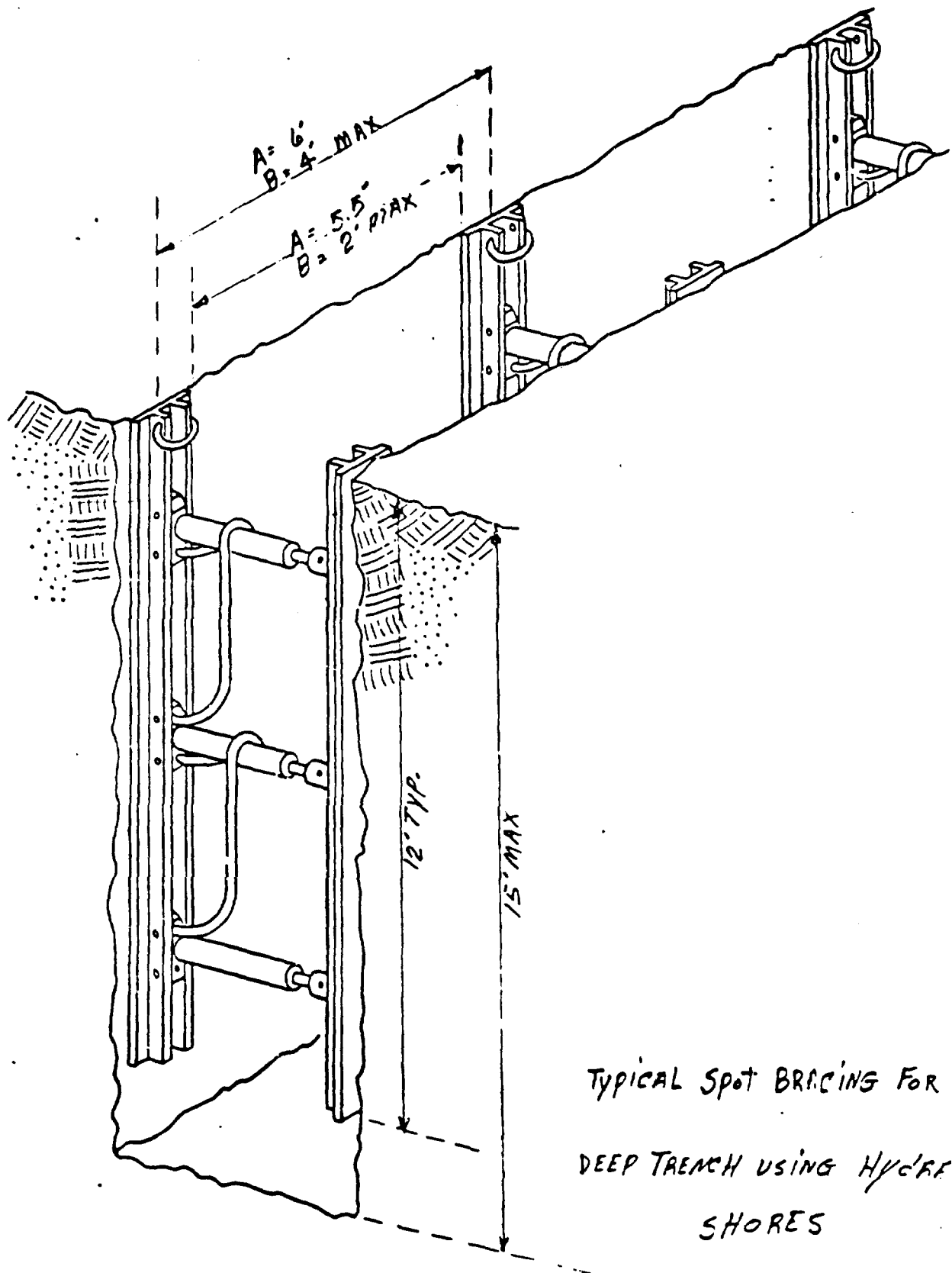
# Typical Spot Bracing for 10 ft Deep Trench Using Hydraulic Shores

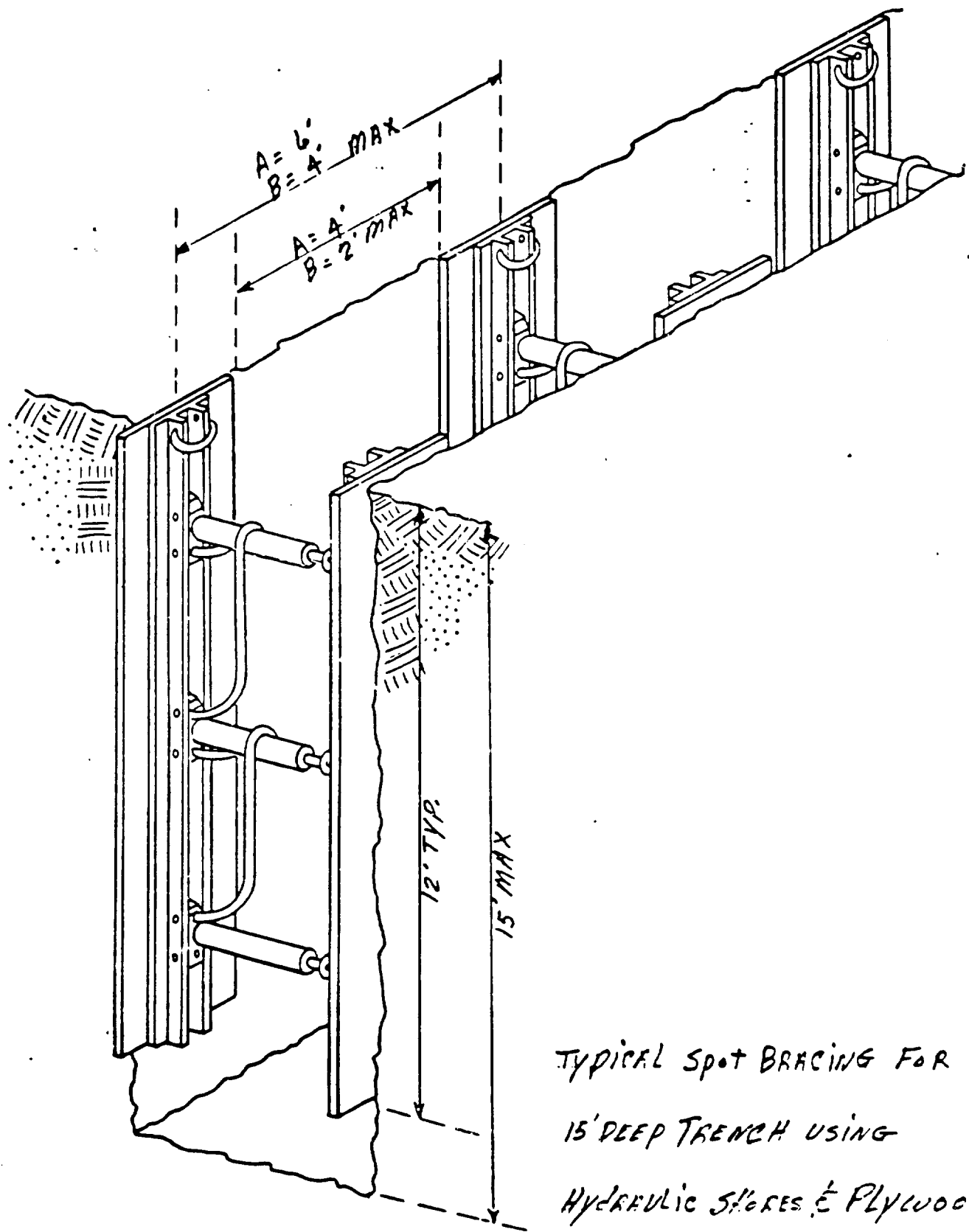




TYPICAL SPOT BRACING FOR 10FT. DEEP TRENCH USING  
HYDRAULIC SHORES AND PLYWOOD

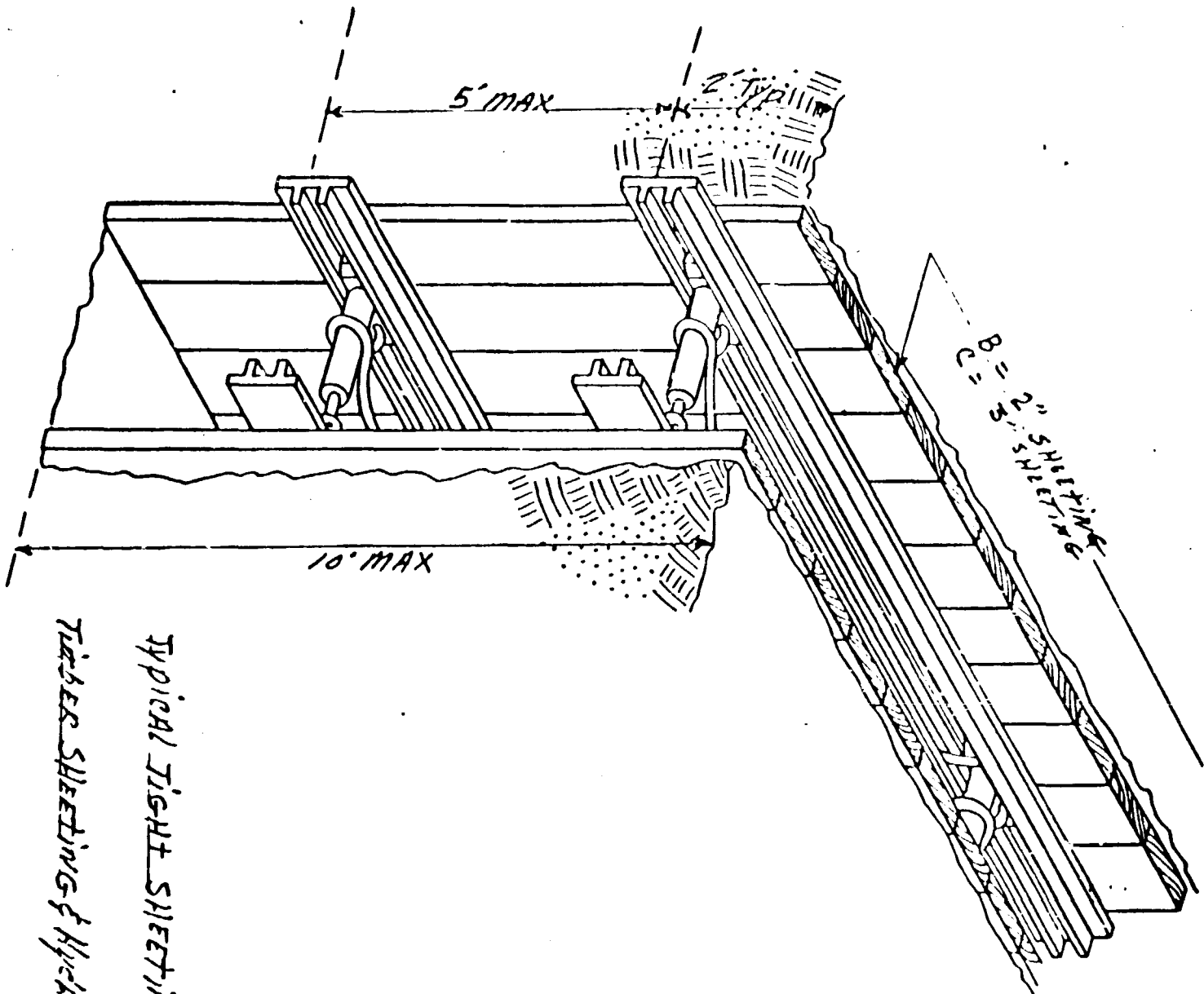




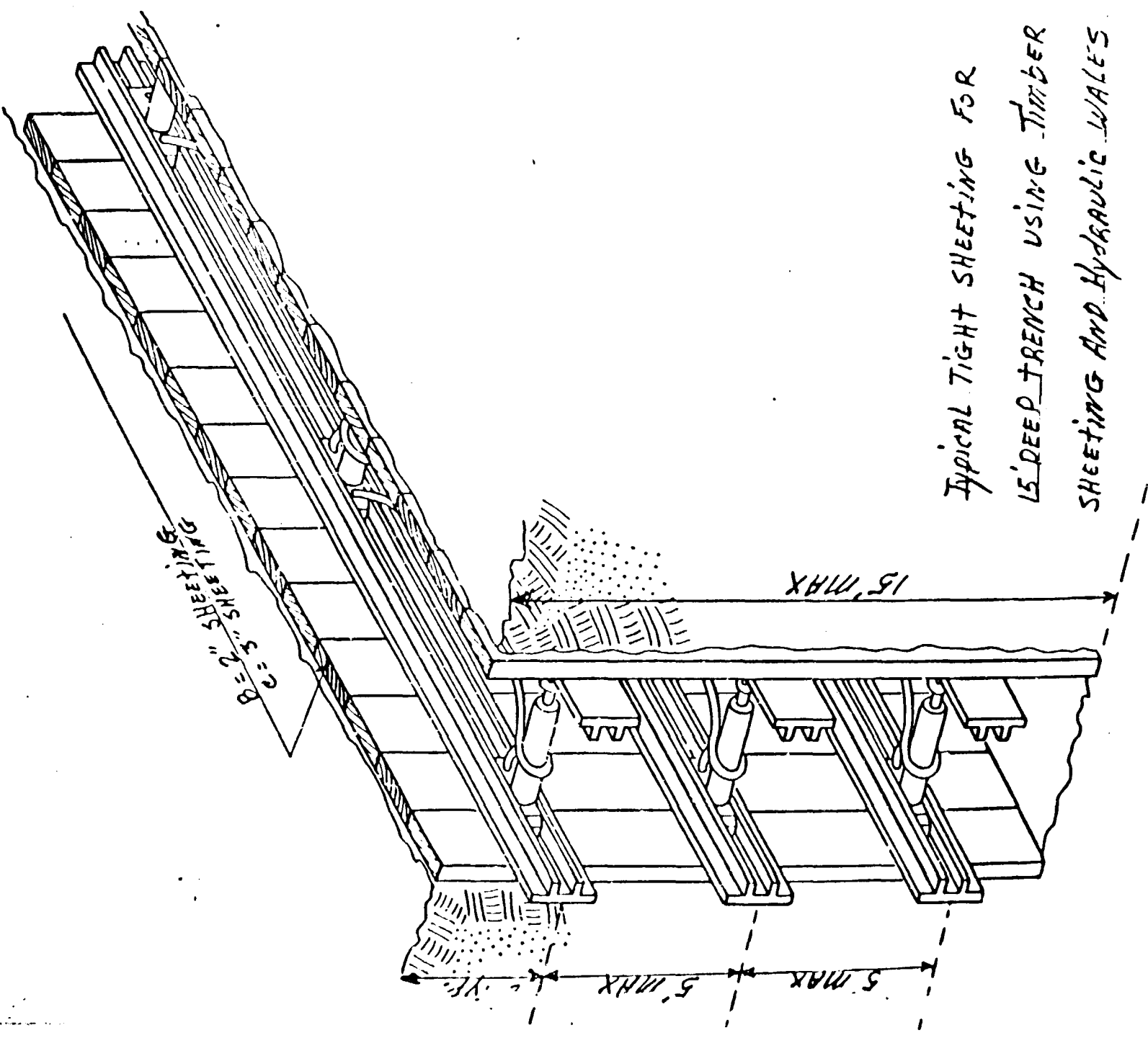


TYPICAL Spot BRACING FOR  
15' DEEP TRENCH USING  
HYDRAULIC SHORES & PLYWOOD



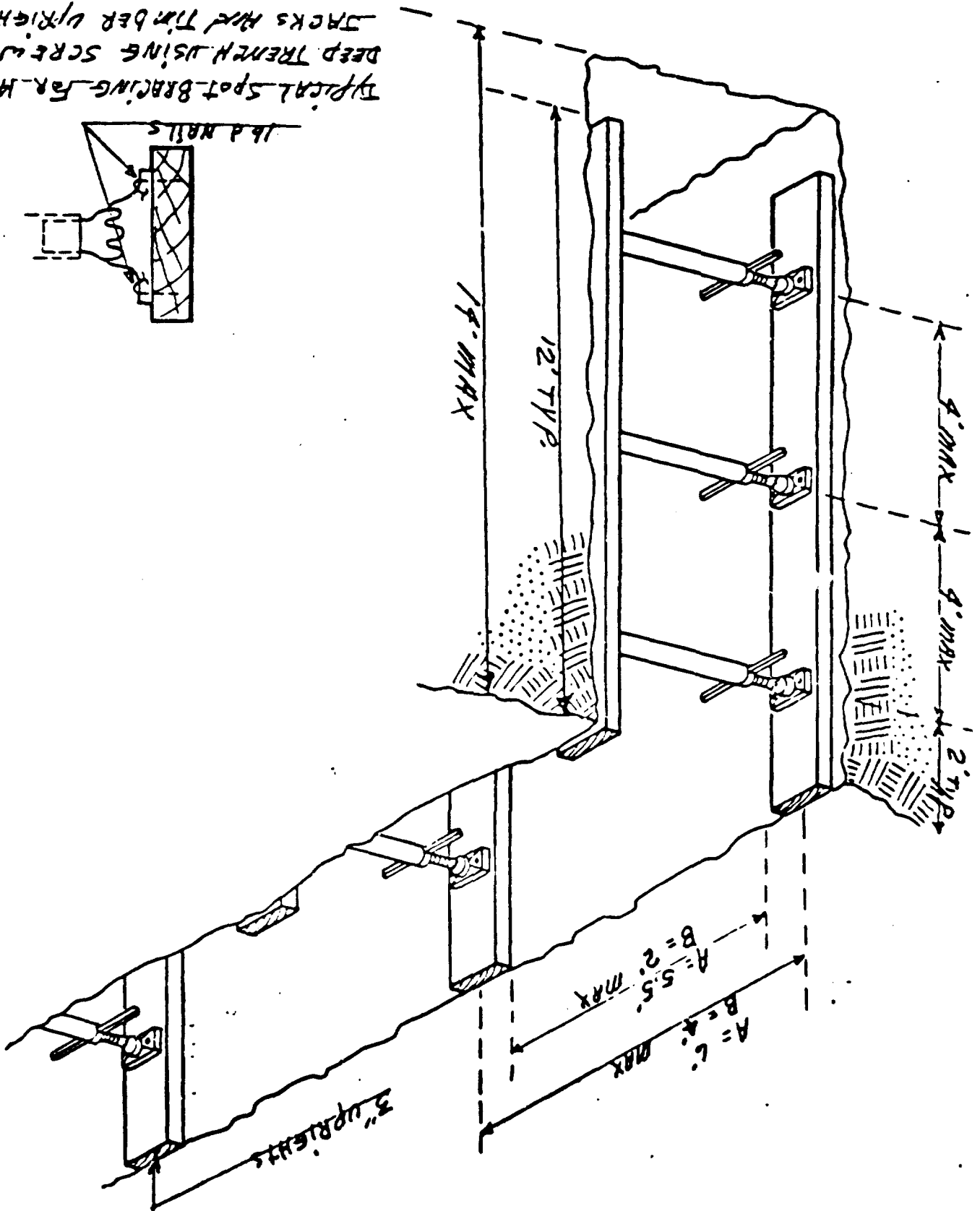
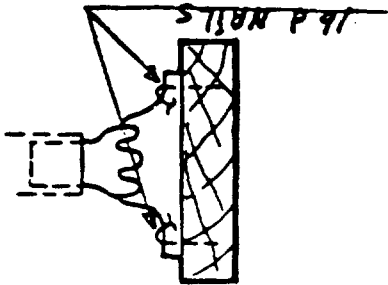


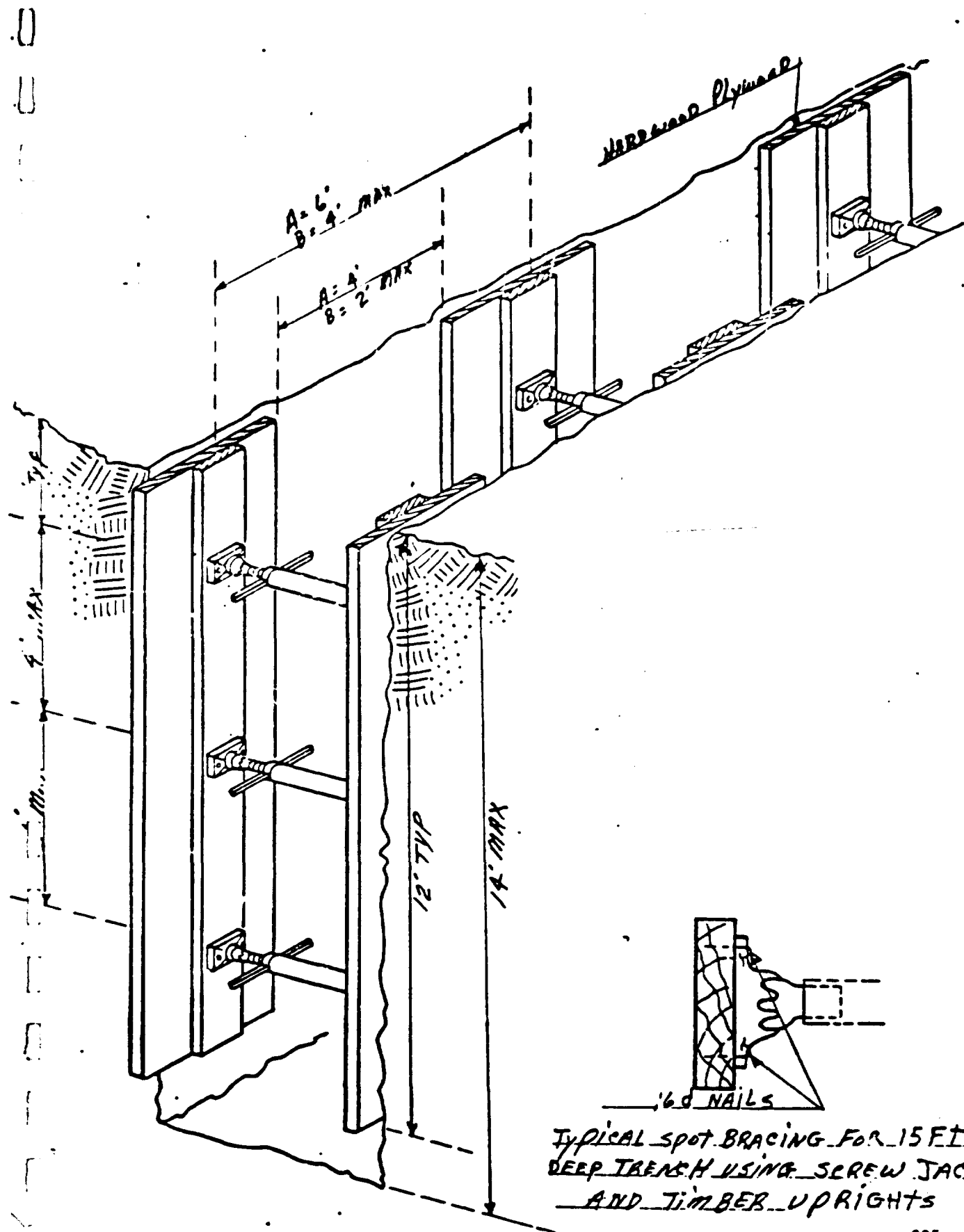
TYPICAL TIGHT SHEETING USING  
 TIMBER SHEETING & HYDRAULIC WALL

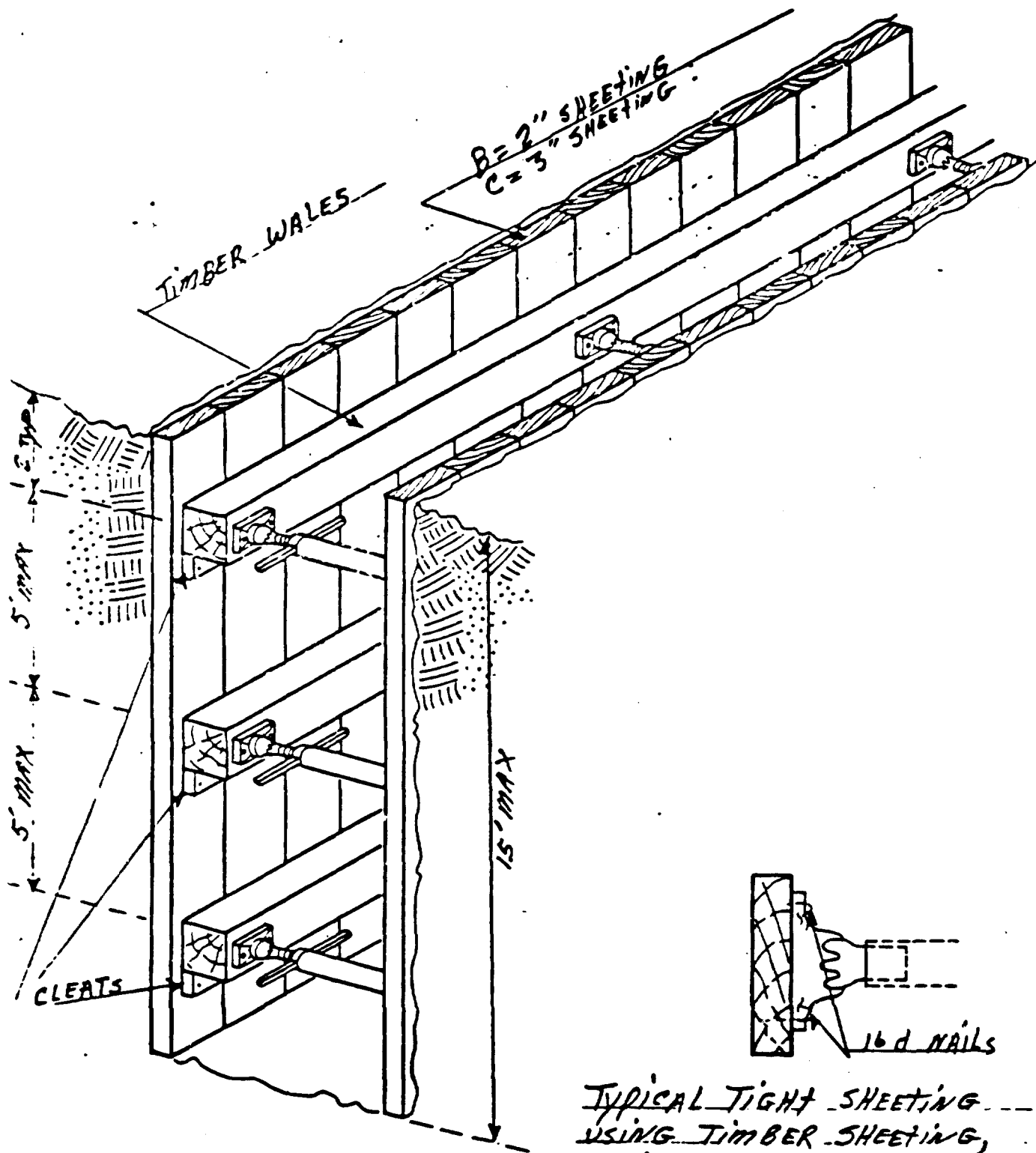


TYPICAL TIGHT SHEETING FOR  
15' DEEP TRENCH USING TIMBER  
SHEETING AND HYDRAULIC WALE'S

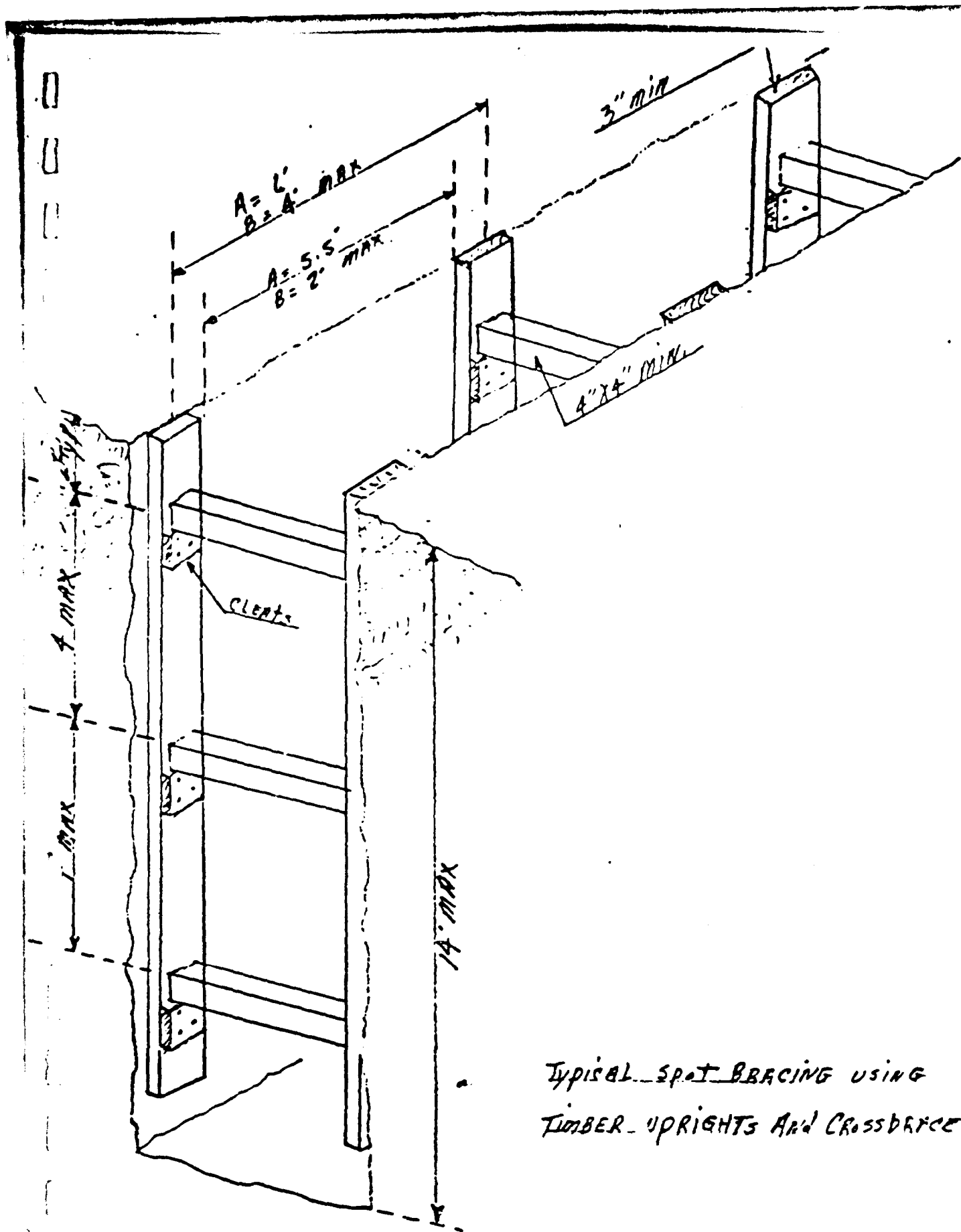
Typical spot bracing for 4 ft  
deep trench using screw  
jacks and timber uprights





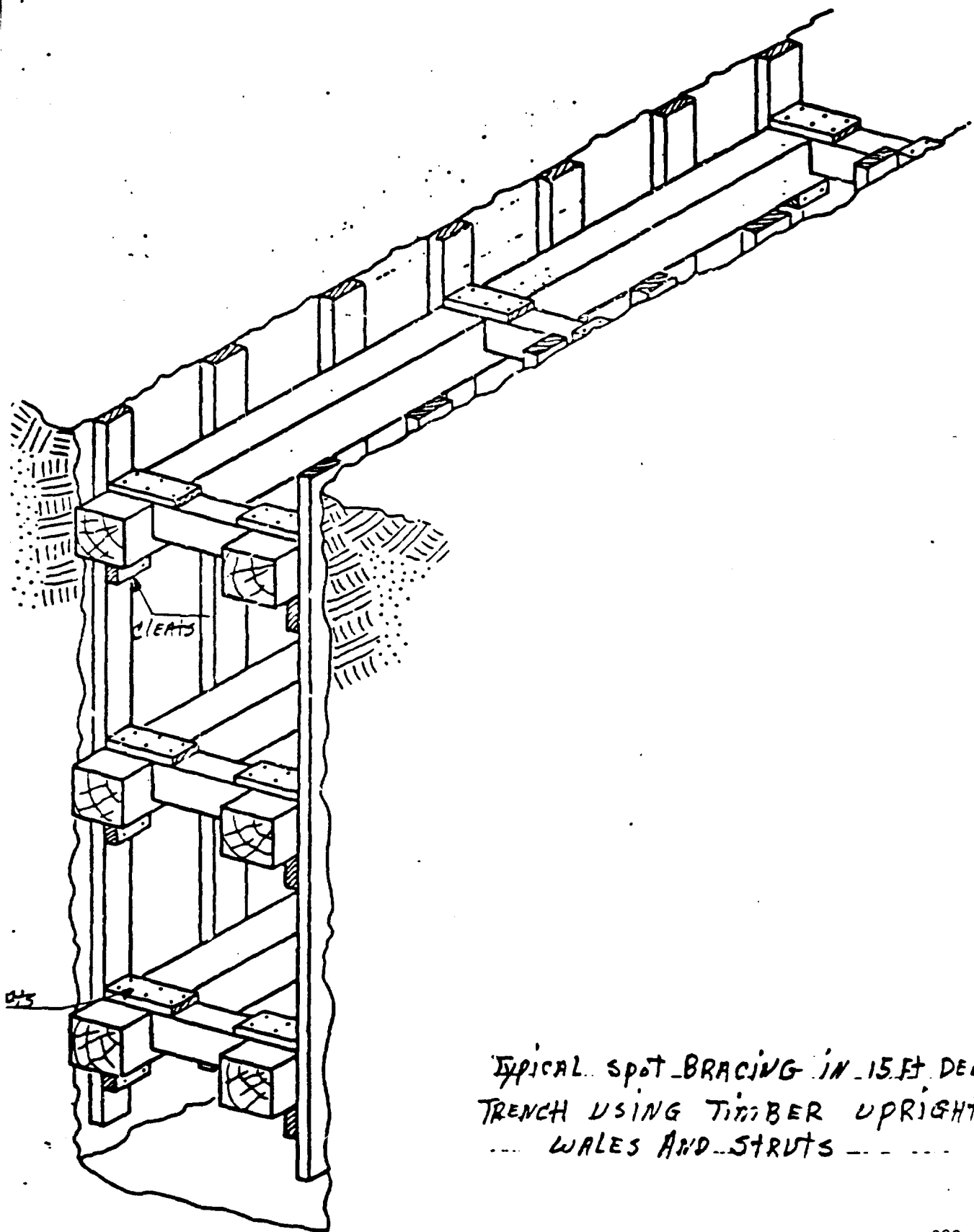


TYPICAL TIGHT SHEETING  
USING TIMBER SHEETING,  
WALES AND SCREW JACKS



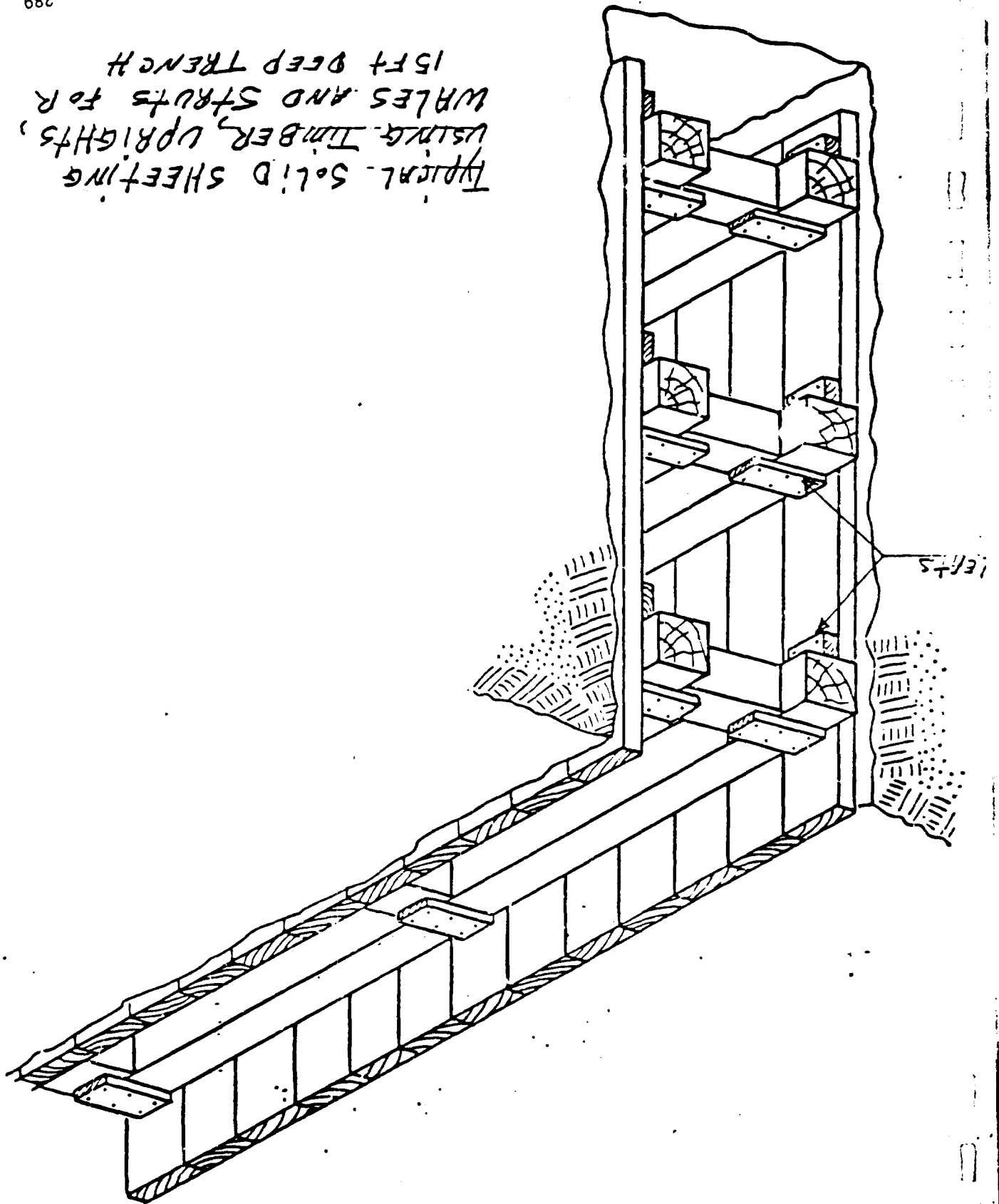
TYPICAL SPOT BRACING USING  
TIMBER UPRIGHTS AND CROSSBRACES





TYPICAL SPOT BRACING IN 15 FT. DEEP  
TRENCH USING TIMBER UPRIGHTS  
WALES AND STRUTS

TYPICAL SOLID SHEETING  
USING TIMBER UPRIGHTS,  
WALES AND STRUTS FOR  
15 FT DEEP TRENCH



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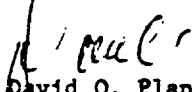
• April 9, 1982

Dr. Felix Yokel  
Geotechnical Engineering Group  
National Bureau of Standards  
United States Department of Commerce  
Washington, D.C. 20234

Dear Felix:

Here is the work that has been approved by the State of California for inclusion in the upcoming reprint of the CAL/OSHA Safety Orders, Title 8, Trench Shoring Tables. As you see, they have addressed themselves to three separate Tables concerning materials for the bracing of trenches - (1) - Timber, (2) - Screw Jacks, and (3) - Hydraulic. All concerned, and including California contractors, feel this clarifies the Code to where they can follow it with ease. The only thing I really disagree with is their decision to go to two classifications of soil - either hard or running with respect to the Tables. I feel they should adopt your system of three classifications of Tables. You might write Mr. Bobis a letter concerning that matter.

Yours very truly,



David O. Plank  
President

DOP:ers

Attachments

cc: Mr. Jim Lapping



**OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

1005 FOURTH STREET  
SACRAMENTO, CA 95814  
(916) 322-3640

March 24, 1982

Mr. David O. Plank, President  
SPEED SHORE CORPORATION  
P.O. Box 12591  
Houston, Texas 77217

Dear Mr. Plank:

We have received your telegram dated March 23, 1982 with respect to the proposed revisions to the Trenches and Shoring Tables 1 through 6, Section 1541 as contained in the Construction Safety Orders, which will be considered by the Standards Board at their Public Hearing on March 25, 1982 in San Diego, California.

Your telegram will be made part of the Board's official record of proceedings in this matter.

We appreciate your interest in this matter and can assure you that your comments will be given every consideration by the Members of the Occupational Safety and Health Standards Board.

Sincerely,

  
R. T. RINALDI  
Executive Officer

/tln

cc: Dr. Alvin Greenberg  
John L. Bobis  
All Standards Board Members

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MAR 26 1982

SPEED SHORE CORP.  
ADM. DEPT.

Memorandum

*Call March 17<sup>th</sup>*  
*Done jep*

To : EXCAVATIONS, TRENCHES AND EARTHWORK  
ADVISORY COMMITTEE MEMBERS

Date: March 10, 1982

*J. L. Bobis*

From : Occupational Safety and Health Standards Board

JOHN L. BOBIS, Principal Safety Engineer

Subject: Trenching Tables, March 25, 1982 Public Hearing

The attached proposed tables will be considered by the Occupational Safety and Health Standards Board at its public hearing scheduled on March 25, 1982 in San Diego, California.

The proposed tables were developed by the Standards Board's staff in response to written comments submitted by persons subsequent to the Board's September 24, 1981 Public Hearing relative to the new proposed regulations on the subject of excavations, trenches and earthwork. Since the suggested revisions to the tables constituted a substantive revision to the September 24, 1981 proposal, the tables could not be incorporated into that proposal without further public hearing. Therefore, this matter will be considered by the Board at its March 25, 1982 Public Hearing. The attached tables are proposed to be incorporated into the new Section 1541 previously heard by the Board and are forwarded to you for your information.

Should you have any questions regarding this matter, please feel free to contact this office.

/tlm

attachment (March 25, 1982 Public Hearing Packet)

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MAR 15 1982

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**OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

100 FOURTH STREET  
SACRAMENTO, CA 95814  
(916) 222-3440

**NOTICE OF PUBLIC MEETING AND HEARING  
OF THE OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD  
AND NOTICE OF PROPOSED CHANGES TO TITLE 8  
OF THE CALIFORNIA ADMINISTRATIVE CODE**

Notice is hereby given pursuant to the provisions of Sections 142, 142.2, 142.3, and 144.6 of the Labor Code, that the Occupational Safety and Health Standards Board of the State of California has set the time and place hereinafter set forth for a Public Hearing, Public Meeting, and Business Meeting:

Public Meeting: On March 25, 1982 at 10:00 a.m. in the Auditorium, of the California State Building, 1350 Front Street, Room B-109 San Diego, California.

At the Public Meeting, the Board will make time available to receive comments or proposals from interested persons on any item concerning occupational safety and health.

PUBLIC HEARING: On March 25, 1982, following the Public Meeting, in the Auditorium of the California State Building, 1350 Front Street, Room B-109 San Diego, California.

At the Public Hearing, the Board will consider the public testimony on the proposed changes noticed below to occupational safety and health regulations in Title 8 of the California Administrative Code.

BUSINESS MEETING: On March 25, 1982, following the Public Hearing, in the Auditorium of the California State Building, 1350 Front Street, Room B-109 San Diego, California.

At the Business Meeting, the Board will conduct its monthly business.

In the event it becomes necessary to continue the Public Meeting, Public Hearing, or Business Meeting, the meetings or hearing will be continued on April 1, 1982 at 10:00 a.m., in the Auditorium of the California State Building, 1350 Front Street, Room B-109, San Diego, California.

These meeting facilities are accessible to the physically handicapped.

OCCUPATIONAL SAFETY AND HEALTH  
STANDARDS BOARD

*Gerald P. O'Hara*  
GERALD P. O'HARA, Chairman

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MAR 15 1982

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ADM. DEPT.

NOTICE OF PUBLIC  
HEARING/MEETING

-2-

March 25, 1982

NOTICE OF PROPOSED CHANGES TO TITLE 8 OF THE  
CALIFORNIA ADMINISTRATIVE CODE  
BY THE OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

Notice is hereby given pursuant to the provisions of Section 142, 142.2, 142.3, and 144.6 of the Labor Code that the Occupational Safety and Health Standards Board will consider the following proposed revisions to the Title 8 Safety Orders of the California Administrative Code, as indicated below, at its Public Hearing on March 25, 1982:

1. TITLE 8: CONSTRUCTION SAFETY ORDERS  
(Trench Shoring Tables 1 through 6)

Informative Digest of Proposed Action: Existing Cal/OSHA regulations in the Construction Safety Orders, concerning trench shoring systems do not address the use of hydraulic shoring units in both a vertical mode (as uprights) or horizontally (as walers) when shoring a trench. The proposed repeal of Section 1541 and the adoption of a new subsection and tables were previously noticed in the California Administrative Register 81, No. 30-2 and considered at Public Hearing on September 24, 1981, to clarify the use of hydraulic shoring systems or units. As a result of testimony received at the September Public Hearing, the Board is now proposing new tables subdivided into 3 types of trench shoring systems used to support the sides of an excavated trench--wood, metal and hydraulic systems. The revised tables relating to hydraulic systems include appropriate spacing of these units in a horizontal or vertical position. There are no Federal counterpart regulations addressing this specific subject matter.

These tables are proposed to be incorporated into the new Section 1541 previously noticed.

A copy of the proposed changes in STRIKEOUT/UNDERLINE format is available upon request to any interested persons from the Occupational Safety and Health Standards Board's Office, 1006 Fourth Street, Third Floor, Sacramento, California 95814. Copies will also be available at the Public Hearing.

An INITIAL GENERAL STATEMENT OF REASONS outlining the purpose and factual basis for the proposed regulation(s) and the substantive facts upon which the Standards Board is relying for proposing the regulation(s) is also available upon request from the Standards Board's office. Inquiries may be directed to Mr. R. T. Rinaldi, Executive Officer at (916) 322-3640.

The following statement of costs will apply to all the proposed regulations to Title 8 to be considered by the Board:

Costs to State Agencies: None

Impact on Housing Costs: None

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ADM. DEPT.

NOTICE OF PUBLIC  
HEARING/MEETING

-3-

March 25, 1982

Federal Funding to State: None

To Local Agencies and School Districts: Pursuant to Section 36, Chapter 1284, Statutes of 1974, the proposed action does not create any obligation for reimbursement by the State to any local agency under Section 2231 of the Revenue and Taxation Code for costs that may be incurred by it in complying with these orders because these orders merely implement Federal law and regulations.

Notice is also given that any interested person may present statements or arguments orally or in writing at the hearing on the proposed actions under consideration. Written comments should be received no later than five (5) working days prior to the date of the hearing. The Occupational Safety and Health Standards Board, upon its own motion or at the instance of any interested person, may thereafter adopt the above proposals substantially as set forth without further notice.

The Occupational Safety and Health Standards Board's rulemaking files on the proposed action(s) are open to public inspection Monday through Friday, from 8:30 a.m. to 4:30 p.m. at the Standards Board's Office, 1006 Fourth Street, Third Floor, Sacramento, California 95814.

There are no building standards contained in these proposed revisions as defined by Health and Safety Code Section 18909.

OCCUPATIONAL SAFETY AND HEALTH  
STANDARDS BOARD

  
GERALD P. O'HARA, Chairman

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ADM. DEPT.



**STANDARDS PRESENTATION**  
**CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD**

---

**TITLE 8: CONSTRUCTION SAFETY ORDERS**  
**(Trenches and Shoring Tables 1 through 6)**

**SECTION**

**SUBJECT**

1541, including  
Tables 1 and 2

Repeal existing regulation on Standard  
Shoring System, including Tables 1 and 2.

Note: The repeal of Section 1541 and the adoption of a new Section 1541 were previously noticed (California Administrative Register 81, No. 30-2) and heard by the Standards Board on September 24, 1981. Because substantive changes to the proposed tables were recommended at the public hearing, the tables are being renoticed for hearing. The tables are proposed to be revised to be consistent with the testimony received by the Standards Board at its September 24, 1981, public hearing. ---

Tables 1 through 6

Adopts new Tables 1 through 6.

-----

There are no building standards contained in this proposal.

Pursuant to Section 36, Chapter 1284, Statutes of 1974, the above order does not create any obligation for reimbursement by the State to any local agency under Section 2231 of the Revenue and Taxation Code for costs that may be incurred by it in complying with this order because this order merely implements Federal law and regulations.

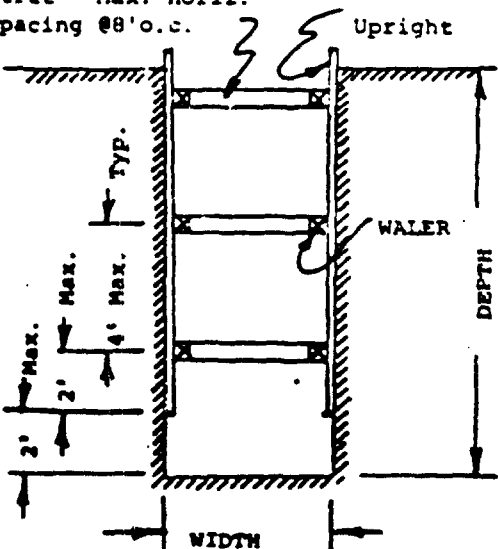
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MAR 13 1982

SPEED SHORE CORP.  
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## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

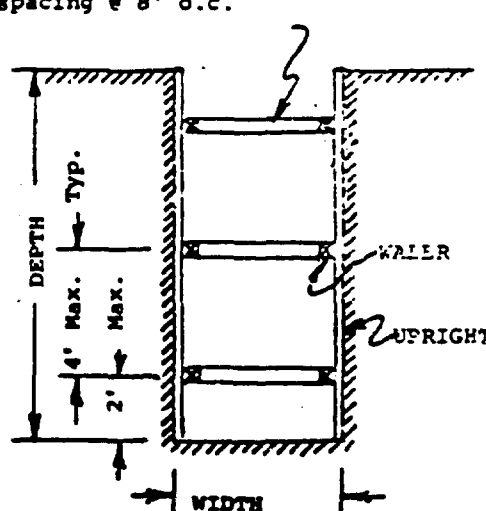
**TABLE 1**  
**WOOD SHORING FOR HARD COMPACT SOIL**

DEPTH (Feet)	Uprights		Braces (Struts) at 8' on centers	Stringer (Waler)
	Horizontal Spacing (Feet)	Size (Inches)	Wood Size (Inches) and Trench Width (Feet)	Size (Inches)
5 to 7	8	3 x 8	4 x 4 All widths up to 15'	-----
	4	2 x 10		4 x 4
	2	2 x 8		4 x 4
Over 7 to 10	8	4 x 10	4 x 4 up to 12' width, over 12' up to 15', 6 x 6	-----
	4	3 x 10		6 x 8
	2	3 x 8		6 x 8
Over 10 to 12	8	6 x 8	4 x 4 up to 8' width, over 8' up to 15', 6 x 6	-----
	4	4 x 8		8 x 8
	2	3 x 8		8 x 8
Over 12 to 15	8	6 x 8	4 x 4 up to 6' width, over 6' up to 15', 6 x 6	-----
	4	4 x 10		8 x 10
	2	3 x 10		8 x 10
Over 15 to 20	8	6 x 10	6 x 6 up to 14' width, over 14' up to 20', 8 x 8	-----
	4	4 x 12		6 x 12
	2	3 x 12		6 x 12
Over 20	See Section 1541(a) (6)		Strut - Max. horiz. spacing @8'o.c.	
<p align="center"><b>GENERAL NOTES</b></p> <p>1. Timber shall be "selected lumber" quality. (See Definitions Section 1504.)</p> <p>2. Timber members of equivalent "section modulus" may be substituted for uprights and stringers shown in these tables.</p> <p>3. These tables may be modified by a civil engineer in accordance with Section 1541(a) (5).</p>				

# CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

**TABLE 2**  
**WOOD SHORING FOR RUNNING SOIL**

DEPTH	Uprights		Braces ( Struts) at 8' on centers	Stringer (Waler)
	Horizontal Spacing (Feet)	Size (Inches)	Wood Size (Inches) and Trench Width (Feet)	Size (Inches)
5 to 8	Solid	2	6 x 6 All widths  up to 15'	8 x 10
Over 8 to 10	Solid	3	6 x 6 up to 10' width, 8 x 8 over 10' width up to 15'	10 x 10
Over 10 to 12	Solid	3	6 x 6 up to 8' width, 8 x 8 over 8' up to 15'	10 x 12
Over 12 to 15	Solid	3	8 x 8 All widths up to 15'	10 x 12
Over 15 to 20	Solid	4	8 x 8 up to 12' width, 10 x 10 over 12' up to 20'	12 x 12
Over 20	See Section 1541(a) (6)		Strut - Max. horiz. spacing @ 8' o.c.	



The diagram illustrates a cross-section of a trench shoring system. On the left, a vertical dimension line is labeled 'DEPTH'. A horizontal line within the trench is labeled 'TYP.'. Two vertical arrows pointing outwards from the trench walls are labeled '4' Max.' and '2''. At the bottom, a horizontal dimension line is labeled 'WIDTH'. On the right side, a horizontal beam is labeled 'WALER' and a vertical post is labeled 'UPRIGHT'. A lightning bolt symbol is shown above the waler.

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## CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

TABLE 3  
METAL SHORING FOR HARD COMPACT SOIL

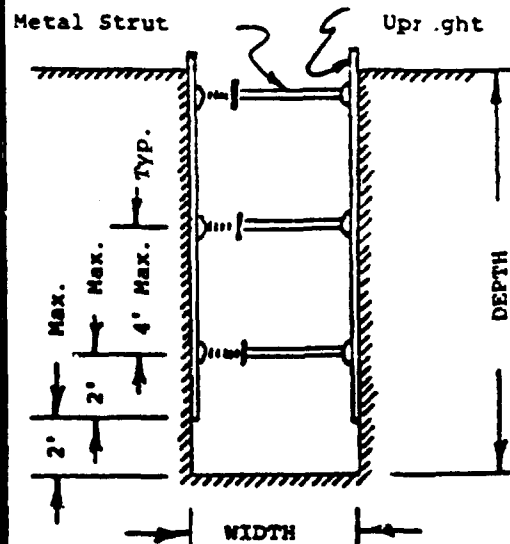
DEPTH (Feet)	Uprights		Braces (Struts) at 8' on centers				Stringer
	Horizontal Spacing (Feet)	Size (Inches)	Aluminum Pipe		Std. Steel Pipe		(Waler) Size
			Min. Dia. (Inches)	Max. Trench Width (Ft.)	Min. Dia. (Inches)	Max. Trench Width (Ft.)	(Inches)
5 to 7	8	3 x 8	2½ (3½)	8 (10)	1½	3	-----
	4	2 x 10	2½ (3½)	8 (14)	1½	3	4 x 4
	2	2 x 8	2½ (3½)	8 (20)	1½	3	4 x 4
Over 7 to 10	8	4 x 10	2½ (3½)	6 (8)	2	6	-----
	4	3 x 10	2½ (3½)	9 (11)	2½	12	6 x 8
	2	3 x 8	2½ (3½)	12 (16)	3	15	6 x 8
Over 10 to 12	8	6 x 8	2½ (3½)	6 (7)	2 (2½)	8 (12)	-----
	4	4 x 8	2½ (3½)	8 (10)	2 (2½)	10 (11)	8 x 8
	2	3 x 8	2½ (3½)	10 (15)	2½ (3)	13 (15)	8 x 8
Over 12 to 15	8	6 x 8	2½ (3½)	5 (6)	2 (2½)	6 (10)	-----
	4	4 x 10	2½ (3½)	7 (9)	2 (2½)	8 (12)	8 x 10
	2	3 x 10	2½ (3½)	9 (13)	2½ (3)	13 (15)	8 x 10
Over 15 to 20	8	6 x 10	2½ (3½)	4 (5)	2½ (3)	8 (12)	-----
	4	4 x 12	2½ (3½)	6 (8)	2½ (3)	10 (15)	6 x 12
	2	3 x 12	2½ (3½)	8 (11)	2½ (3)	12 (15)	6 x 12

Over  
20  
See Section 1541(a)  
(6)

## GENERAL NOTES

1. Metal pipe braces permitted by these Orders shall be schedule 40, standard steel pipe, or equivalent and installation shall be as set forth by these Orders.
2. Timber shall be "selected lumber" quality. (See Definitions - Section 1504.)
3. Timber members of equivalent "section modulus" may be substituted for uprights and stringers shown in these Tables.

(continued - Table 4)



# CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH STANDARDS BOARD

**TABLE 4  
METAL SHORING FOR RUNNING SOIL**

DEPTH (Feet)	Uprights		Braces (Struts) at 8' on Centers				Stringer
	Horizontal Spacing (Feet)	Thickness (Inches)	Aluminum Pipe		Std. Steel Pipe		(Waler) Size (Inches)
			Min. Dia. (Inches)	Max. Trench Width (Ft.)	Min. Dia. (Inches)	Max. Trench Width (Ft.)	
5 to 8	Solid	2	2½ 3	8 10	1½ 2	3 6	8 x 10
Over 8 to 10	Solid	3	2½ 3	6 8	2 2½	6 12	10 x 10
Over 10 to 12	Solid	3	2½ 3	4 6	2 2½	6 10	10 x 12
Over 12 to 15	Solid	3	2½ 3	3 6	2½ 3	8 15	10 x 12
Over 15 to 20	Solid	4	3 3½ 4	6 8 10	2½ 3 3½	6 12 15	12 x 12

Over  
20 See Section 1541(a)  
(6)

4. These tables may be modified by a civil engineer in accordance with Section 1541 (a) (6).

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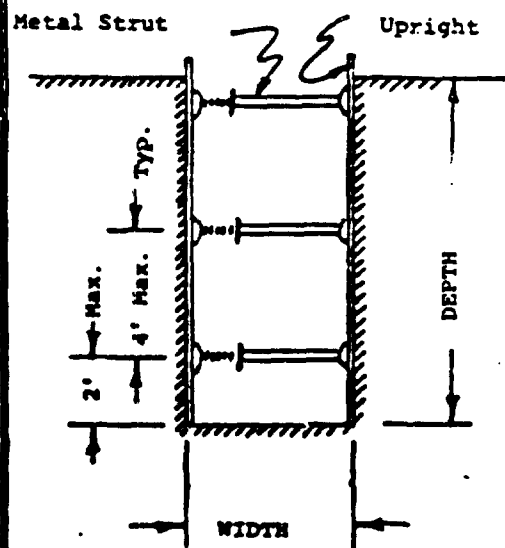


TABLE 5  
HYDRAULIC SHORING FOR HARD COMPACT SOIL

DEPTH (Feet)	Uprights		Stringers (Waler)		Braces (Struts)			
	Horizontal Spacing (Feet)	Size Aluminum Rail	Size Aluminum Rail	Vertical Spacing (Feet)	Hydraulic Cylinders	Horizontal Spacing (Feet)	Max. Trench Width (Feet)	
5 to 7	8 No Sheeting	8" Wide Standard	6" Wide Standard	5	2" ID - 2½" OD	8 cc	12	20**
	6			" " " "				
	5			" " " "				
* (See Note)								
Over 7 to 12	8 No Sheeting	8" Wide Standard	6" Wide Standard	5	2" ID - 2½" OD	8 cc	9	20**
	6			" " " "				
	5			" " " "				
* (See Note)								
Over 12 to 16	6 No Sheeting	8" Wide Std. or HD	6" Wide Std. or 8" Wide HD	5	2" ID - 2½" OD	6 cc	9	20**
	4			" " " "				
	5			" " " "				
* (See Note)								
Over 16 to 20	6 No Sheeting	8" Wide Std. or HD	6" Wide Std. or 8" Wide HD	4	2" or 3" ID -	4 cc	9	20**
	4			or				
	4			2½" or 3½" OD				
* (See Note)								
Over 20	See Section 1541(a)(6)		GENERAL NOTES					

**TABLE 6**  
**HYDRAULIC SHORING FOR RUNNING SOIL**

DEPTH (Feet)	Uprights		Stringers (Walers)		Braces (Struts)		
	Horizontal Spacing (Feet)	Size Aluminum Rail	Size Aluminum Rail	Vertical Spacing (Feet)	Hydraulic Cylinders	Horizontal Spacing (Feet)	Max. Trench Width (Feet)
5 to 7	Solid *	8" Wide Standard	6" Wide Standard	4	2" ID - 2 1/2" OD	6 cc	9 20**
Over 7 to 12	Solid *	8" Wide Standard	6" Wide Standard	4	2" ID - 2 1/2" OD	6cc	9 20**
Over 12 to 16	Solid *	8" Wide Standard	6" Wide Standard	4	2" or 3" ID ex. 1 1/2" <i>7</i> 2 1/2" or 3 1/2" OD	4 cc	8 15**
Over 16 to 20	Solid *	8" Wide Standard	6" Wide Standard	3	2" or 3" ID <i>Slime</i> ex. 1 1/2" <i>ex. 1 1/2"</i> 2 1/2" or 3 1/2" OD	3 cc	6 15**
Over 20	See Section 1541(a) (6)		GENERAL NOTES				

- 1) \* Use plywood or other effective sheeting behind the vertical uprights.
- 2) \*\* Use steel box encasement in this range.

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SPEED SHORE CORP.  
ADM. DEPT.



October 7, 1980

Felix Y. Yokel, Ph.D., P.E.  
U.S. Department of Commerce  
National Bureau of Standards  
Geotechnical Engineering Group  
Building 226, Room B162  
Washington, D.C. 20234

Dear Mr. Yokel:

We appreciate your desire to include plywood as a material in your revisions to the regulations for "Excavation, Trenching and Shoring." I hope that we can agree on a criteria that will permit us to supply you with some type of tabular load information for the use of plywood sheeting in trench shoring.

The four-page leaflet I sent to you earlier entitled, "Plywood Trench Shoring," was produced some six or seven years ago and all of the people involved with it are no longer working at APA. This causes a problem in trying to reconstruct the thinking and decisions that went into production of the tables in that publication. After searching our file, I have some answers, but in some cases I can only speculate on the reasoning.

APA at that time saw plywood used in trench shoring in situations that definitely could not be justified from a theoretical engineering calculation standpoint. Thus, in developing the tabular data, generous assumptions were made in any case where they could be substantiated with reasonable engineering judgement. Not being experts in soil engineering, we sidestepped that issue by quoting from some handbooks and giving pressures in terms of a number of levels of equivalent fluid density.

All tolled, there are a number of areas where our computations and judgements vary from the BSS 127 "standard practice." In the tabular data the depth of the trench did not have built into it any surcharge allowance. Thus, the two-foot mandatory surcharge you are implying would reduce the effective depth of the trench by two feet for the tabular information given in the APA brochure.



7011 So. 19th St. / P.O. Box 11700 / Tacoma, Washington 98411 / 206 565-6600  
TLX 32 7430



While not stated in our publication, the design example implies that thinner sheeting could be used for the upper part of the trench and a thicker panel for the lower part. This requires the assumption that the earth pressure varies from a maximum at the trench bottom to zero at the surface of the ground.

In developing the APA publication, information was borrowed from a California publication on excavations and trenches to justify using a 6/10 factor times the depth times the equivalent fluid density to determine effective pressure on the plywood. This 6/10 factor would apparently correspond to the 67% tributary loaded area factor given in BSS 127. Though not stated, I assume this factor is inserted to account for the nonuniform pressure of the earth on the retaining structure. As it is pointed out, if the structure can deflect slightly, it will essentially unload itself in that area.

In designing the retaining structure, APA computed on the basis of wet stresses whereas most plywood structures utilize dry stress levels. After starting from a normal duration stress level, (ten years) a 33% increase on the stress was applied for the shoring duration. Since a 33% duration increase is only appropriate for durations of about one day, I suspect that it is in fact more appropriately entitled "experience factor" with duration of loading as only one aspect of this stress increase.

The tabulated information given in the APA brochure covers the equivalent fluid density range from 20 to 80 pcf, and thus we have covered the range for soil types A, B and C.

In the computations for the table in the APA literature, we have used span lengths from center of support to center of support. We have at the same time reviewed computations by other design engineers where the clear span distance was used since the supports may be relatively wide. If one is using verticle supports for the plywood sheeting, that is a 2 or 3 x 8 flat, the span length changes substantially and the ability of the plywood panel to resist load increases greatly. However, since the width of the support is a variable and not necessarily one easily controlled, this becomes an individual matter. I suppose, one could assume a minimum six-inch width of support in all cases. This would be about the least that could be expected.

I'm enclosing an APA laboratory report on the affect of support width on plywood deflection. While trench shoring is not deflection critical, the information gained from the research regarding deflection certainly indicates that something other than center-to-center span length is appropriate for strength calculations as well as for deflection calculations.

In order to fit APA data into the criteria you have suggested in your BSS 127, I would suggest the following:

1. Normal duration wet stresses increased 33% for short duration shoring.
2. A 67% tributary load factor for the plywood sheeting.
3. Trench depth computed with a two foot surcharge.

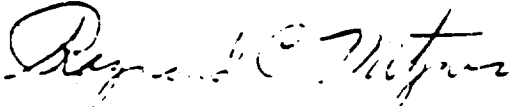
Felix Yokel

-3-

October 7, 1980

4. Span length computed as clear span plus 5/8 inch, six-inch support width assumed.
5. Same thickness plywood from top of trench to bottom.

Sincerely yours,



RAYMOND C. MITZNER, P.E.  
Project Manager, Industrial Markets  
Engineering Technology

RCM/saw

Enclosure: Lab Report 120

# Plywood Trench Shoring

AMERICAN PLYWOOD ASSOCIATION 1119 A St. Tacoma, WA 98401 206 272-2283

This leaflet has been prepared as an aid in designing trench shoring using APA® grade-trademarked plywood. Four basic framing systems are illustrated, and plywood recommendations are given.

Plywood may be used most readily for trenches up to 8 feet deep. Greater depths are permissible in some soils. In most shoring systems, it is best to orient the plywood face grain across the supports in order to have the strongest and stiffest system. For some conditions, however, plywood panels may be used more efficiently if oriented vertically; that is, with face grain parallel to supports. Minimum support framing is also desirable, since horizontal support jacks restrict work inside the trench.

With these points in mind, four plywood-support configurations have been calculated for commonly available plywood grades. Tabular information is also presented to aid the designer in estimating soil pressures, and in selecting appropriate plywood grades and thicknesses.

Four steps are involved in plywood trench shoring design:

1. Determine equivalent fluid density of soil.
2. Select a suitable plywood-support system.
3. Select the proper plywood grade and thickness for the support framing.
4. Design the support framing.

## Earth Pressures on Shoring

Soil-engineering references generally refer to three types of soil pressures for shoring design: active, at rest, and passive. At-rest pressures assume no movement of the wall. Passive pressures result from the wall pushing against the soil until it fails. For most shoring, these two types of soil pressure are not design factors.

Active soil pressure can be safely assumed for most trench shoring. Active soil pressure can be used where design permits slight movement of the shoring away from the soil. For most systems, this movement is provided by the inherent flexibility of the plywood and framing.

The active soil pressure depends on the angle of internal friction of the soil; soil cohesion, density, and water content; and depth of the trench. The interaction of these variables is explained in detail in various references.<sup>1</sup>

The general properties of some soil classifications are known. Using these properties, the soil can be transformed into an "equivalent fluid" whose density relates to the pressure exerted by the soil. Some building codes specify a 30 pcf equivalent fluid density as a minimum design requirement for foundations.<sup>2</sup>

Table 1 shows equivalent fluid densities for various common soil classifications. A range of densities has been shown since these soil classifications are not definitive of every soil property.

Table 1 Equivalent Fluid Density of Soils\*

Soil Classification	Equivalent Fluid Density (pcf)
Soft flowing mud	75-85
Wet fine sand	35-70
Dry sand	25-45
Gravel	25-45
Compact loam	15-40
Loose loam	25-55
Clay	15-85

\* Based on tabular information given in *Building Construction Handbook* by Merritt.

After determining which soil classification applies to the soil at the job site, the designer must use professional judgment in selecting the appropriate equivalent fluid density for his application. For instance, Table 1 shows an equivalent fluid density of 35 to 70 pcf for wet fine sand. The designer may determine by inspection that the actual soil is sand that does not contain a high percentage of fines. After comparing the properties given for dry sand, he may decide that an equivalent fluid density of 50 or 60 pcf would be more appropriate. In any event, the designer should regard Table 1 as a general guide for estimating soil pressure. After selecting an equivalent fluid density, the design pressure is six-tenths of the product of the equivalent fluid density times the depth of the trench.<sup>3</sup>

<sup>1</sup> *Soil Mechanics in Engineering Practice* by Terzaghi & Peck.

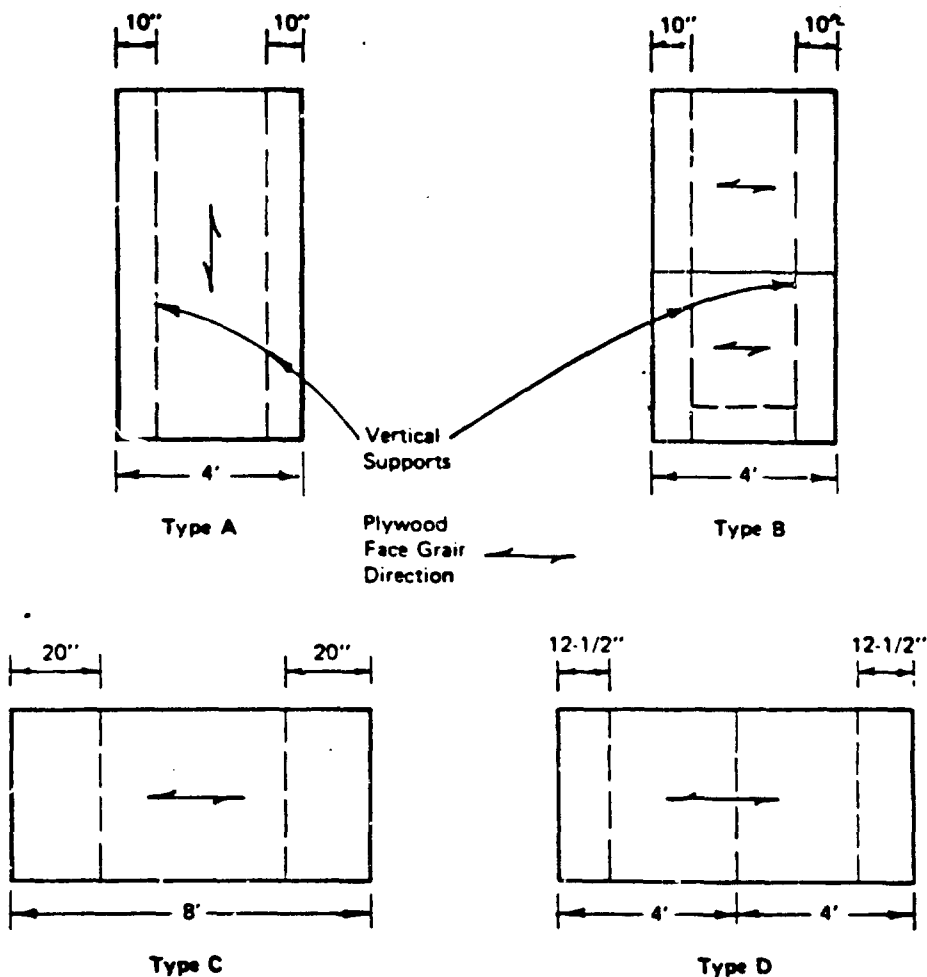
<sup>2</sup> *Uniform Building Code*, 1973.

<sup>3</sup> *Excavation and Trenches*, Agricultural and Services Agency, Department of Industrial Relations, State of California.

## Framing Systems

The following illustrations show four basic framing systems for trench shoring.

In Types A, B, and C, each panel is supported by only two framing members, but they are so spaced that the bending moments in the panel will be minimized. That is, the moment at the supports is the same as at the midspan of the panel. Spacing of supports for Type D has been selected in a similar manner.



The moment in all four systems is determined by the following equation:

$$M_{\text{supports}} = M_{\text{center}} = K w B^2$$

$M$  = Moment (ft lb)

$K$  = 0.0214 (Types A, B, C)

= 0.00853 (Type D)

$w$  = soil pressure (psf)

$B$  = total panel dimension (ft)

$B$  = 4 ft for types A and B

= 8 ft for Types C and D

In some cases, the shear stress may be critical in the design, so this should also be checked. Shear is maximum at the supports and is determined by the following equation:

$$V = Z w B$$

$V$  = maximum shear (lb)

$Z$  = 0.293 (Types A, B and C)

= 0.185 (Type D)

By using the equations for maximum moment and shear, the engineer can determine the required plywood system. In order to simplify the plywood design, Table 2 has been prepared, giving the maximum depth of fill behind each support system for various equivalent fluid densities.

**Table 2 Allowable Depths of Plywood Trench Shoring (Ft)**

Required Plywood Grade	Support Type	Equivalent Fluid Density (pcf)						
		20	30	40	50	60	70	80
C-D 32/16 INT APA w/ext. glue	B	7.5	5.0	3.8				
	D	4.7	3.1					
C-C 32/16 EXT APA	B	9.0	6.0	4.5	3.6			
	D	5.6	3.8					
C-D 42/20 INT APA w/ext. glue	B	11.5	7.7	5.8	4.6	3.8		
	D	7.2	4.8	3.6				
C-C 42/20 EXT APA	B	13.8	9.2	6.9	5.5	4.6	3.9	
	D	8.6	5.8	4.3	3.5			
C-D 48/24 INT APA w/ext. glue	A	7.6	5.1	3.8				
	B	15.0	10.0	7.5	6.0	5.0	4.3	3.8
	D	9.4	6.3	4.7	3.8			
C-C 48/24 EXT APA	A	9.0	6.0	4.5	3.6			
	B	18.0	12.0	9.0	7.2	6.0	5.1	4.5
	C	4.4	3.0					
	D	11.3	7.5	5.7	4.5	3.8		
5/8" PLYFORM Class I	A	8.0	5.3	4.0				
	B	11.5	7.6	5.7	4.6	3.8		
	D	7.2	4.8	3.6				
3/4" PLYFORM Class I	A	13.3	8.9	6.7	5.3	4.4	3.8	
	B	14.6	9.7	7.3	5.8	4.9	4.2	3.7
	D	9.2	6.1	4.6	3.7			
2-4-1 w/ ext. glue	A	23.2	15.4	11.6	9.3	7.7	6.6	5.8
	B	30.2	20.1	15.1	12.1	10.1	8.6	7.6
	C	7.5	5.0	3.7				
	D	19.0	12.7	9.5	7.6	6.3	5.4	4.7

The plywood specified in Table 2 is based on the minimum structural properties for the indicated grades. Basic plywood design stresses for wet applications were taken from *Plywood Design Specification* (Form Q510) and then increased 33% for duration of load.

A similar level of design stress was used in development of a shoring system for the Northwest National Gas Company in Portland, Oregon. Their tests demonstrated "safety factors" within the range required by the Occupational Safety and Health Administration.

## Design Example

### Requirements

Shoring is to be designed for a pipe trench varying from 4 feet to 8 feet deep. Horizontal supports are to be kept to a minimum.

### Solution

1. Determine soil properties: No soil-test report is available, but inspection at the job site reveals a loose loam in most areas, with a coarse sand and gravel mixture in others. Road cuts in the area indicate these general soil characteristics to a depth of more than 10 feet.

From Table 1, an equivalent fluid density of 40 pcf is selected as appropriate for the overall design. (With fine-grain soils such as clays, the possibility of wet conditions should also be considered. Rain runoff, or other drainage could produce a hydrostatic head of water under extreme conditions.)

2. Select a suitable plywood-support system:  
Since the trench depth will vary, Type B support system will be used.
3. Select the proper plywood:  
Table 2 shows that C-C EXT 32/16 plywood will be adequate for the Type B system up to a trench depth of 4.5 feet, and C-C EXT 48/24 will be required for the Type B system for depths up to 9.0 feet.

4. Design of support framing is beyond the scope of this technical note, but basic engineering beam formulas for uniform loading can be applied. Vertical-support design will depend on the number and placement of horizontal supports. Use of horizontal supports across the vertical framing can reduce the required number of support jacks—especially for Type A and Type B systems. For most applications at least two support jacks will normally be required for each framing member in trench depths up to 8 feet. Vertical framing should be designed to be stable under lateral impact loads due to workmen and equipment in the trench. This factor is of particular importance for trench depths over 4 feet.

### Note

The Identification Index given in Table 2 as a set of two numbers in the plywood grade (e.g. C-D 32/16) refers to spacing of framing members. The left-hand number is maximum recommended spacing in inches o.c. for roof framing. The right-hand number is the recommendation for floor framing. The Identification Index on any given panel is based on panel thickness and species makeup and indicates relative along-the-grain stiffness of the panel.

*The recommendations in this leaflet are based on use of plywood that bears the grade trademark of the American Plywood Association. For these engineered applications that involve safety, it is best to use plywood that meets manufacturing standards of U.S. Product Standard PS 1 and Association performance requirements. The APA grade-trademark is positive identification by the manufacturer that the plywood has been subject to the rigid inspection and testing program of the Association.*



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